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JOURNAL

OF THE

AMERICAN PEAT SOCIETY

INCORPORATED

A QUARTERLY JOURNAL DEVOTED TO THE DIFFUSION OF KNOWLEDGE CONCERNING PEAT AND TO THE UTILIZATION OF AMERICAN PEAT RESOURCES

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AMERICAN PEAT SOCIETY.

SCOPE AND PURPOSE.

The American Peat Society was organized at the national exposition at Jamestown, Va., on October 23, 1907, and was incorporated in 1912. Its purpose is to disseminate information concerning the origin, metamorphosis, geographic distribution, physical and chemical properties, and uses of peat, muck, and humus, and to stimulate interest in the commercial utilization of the widely-distributed, valuable deposits of these substances in North America.

NATURE AND USES OF PEAT.

Peat is the organic residuum resulting from the arrested decomposition of leaves, twigs, roots, trunks of trees, shrubs, mosses, and other vegetation in areas continually covered or saturated with water. It may be identified as the dark-colored soil found in bogs and swamps, commonly called muck. The commercial uses of peat are numerous and varied. In the countries of northern Europe it is used for fuel and as the basis for many manufacturing industries. Gas, substitutes for petroleum products, charcoal, coke, and a number of valuable by-products are produced in small quantities from it. Peat moss, marsh grass, and fibrous peat are employed in the manufacture of surgical dressings, of rugs and carpets, of packing material, of artifical wood, of paper, and of substitutes for cotton and cloth. In the United States peat is utilized chiefly as an ingredient of fertilizers and stock food and as a crop soil.

ECONOMIC ASPECTS OF PEAT.

The United States contains about 12,000 square miles of undrained land estimated to be capable of yielding nearly 14 billion short tons of air-dried peat. The average deposit will yield 200 tons per acre foot. The peat areas are distributed throughout the Great Lake, New England, and Atlantic and Pacific Coast States. The peat deposits of Canada cover 37,000 square miles. The annual value of the products made from peat in the United States amounts to about $1,000,000. The proceeds received from the cultivation of peat and muck land are far in excess of this figure. European countries annually consume more than 50 million tons.

MEMBERSHIP.

The present membership of the American Peat Society consists largely of agriculturists and peat producers. Persons interested in agriculture, in soil fertilization, in the chemical and bacteriological aspects of vegetal mat-

ter, and in the production of fuel or generation of power are urged to join. Enrollment will be found as valuable by them as it is to the owners and operators of peat and muck areas, who consider their connection with the society a decided business asset. Applications should be addressed to the secretary. Membership and subscription to the journal cost $5.00 a year.

CONVENTIONS AND PUBLICATIONS.

The meetings of the society are held annually in important cities throughout the peat regions. Many original papers relating to the subjects enumerated are presented every year. A quarterly journal containing the proceedings of the society, news of the industry and contemporary literature concerning all phases of the peat and allied industries is published and sent to members. This journal is unique among the scientific publications of the United States, as it is the only one that treats all branches of the peat industry. Its success in stimulating interest in the possibilities of peat, in pointing out the location of deposits, in explaining production methods, in exposing the incompetent engineering practice that has caused many failures, and in stamping out false promotion, has been the subject of favorable comment throughout the world.

General inquiries relating to the objects of the society will be answered free of charge by the secretary or editor, but it should be understood that detailed information will not be so given. Such advice can be obtained from experts whose names will be furnished upon application.

APPLICATION FOR MEMBERSHIP
IN THE
American Peat Society.

(Date)

MR. CHARLES KNAP, *Secretary-Treasurer,*
American Peat Society,
2 Rector St.,
New York, N. Y.

Dear Mr. Knap:

Application is hereby made for membership in the American Peat Society. Check in the sum of $5.00 for subscription to the Journal of the American Peat Society during the first year is inclosed. It is understood that the payment of this sum will admit me to the society and entitle me to all the privileges granted to members by the constitution. This action is prompted by my interest in the utilization of peat and the welfare of the society.

Yours very truly,

(Signature)

(Address)

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A NEW ERA IN THE PEAT INDUSTRY.

By C. C. Osbon.

Peat Attracts Much Attention.

At no time in the history of the American Peat Society have the prospects for the growth of a large and important industry based upon peat been as promising as they now are. In earlier years the peat deposits were little noticed, but with the stimulus recently brought about by our strained economic conditions, the demand for large crops, the shortage and high price of fertilizer ingredients, the increasing cost of coal, and the ever-expanding demand for fuel, more attention has been directed in late years to the possibility of using peat on a large commercial scale than was given to it during the entire preceding history of the United States. In consequence the results that have been accomplished by research work in field and laboratory are ample justification for the investment of the capital that has been attracted. In view of this condition it is believed that the significance of our vast undeveloped peat deposits is becoming more widely appreciated and that peat promises soon to take an active part in the industrial and agricultural progress of the United States.

Progress of Peat Industry Interesting.

The progress of the domestic peat industry since it attained commercial proportions in 1908 constitutes an interesting phase of the development of our natural resources. In the early history

of this country little was known concerning the nature of peat and its use was confined to fuel in the households of settlers from northern Europe. A few years later attempts were made to produce peat fuel commercially, but they were unsuccessful because of the lack of engineering experience and the failure fully to appreciate its physical and chemical characteristics. However, about 1908 experiments were completed that demonstrated the value of peat in agriculture and by means of improved methods of handling and a better appreciation of the vital necessity of eliminating the moisture by air-drying in the field a few operators succeeded in profitably marketing peat as a fertilizer ingredient. Since then the growth of the industry has been steady despite the criticism of persons who were unfamiliar with its characteristics.

Peat Fertilizer Promising.

The largest and most successful use that has been made of peat in the United States is in the compounding of commercial fertilizers. The peat deposits are one of the few extensive known sources of organic nitrogen in this country that can be converted into plant food at a price that is economic to the farmer. Analyses of these peats show a nitrogen content ranging from 1 to 5 per cent, which may be recovered in the form of ammonium sulphate or made available for plant food without extracting it from the peat. Arguments are often advanced against the direct use of peat as a source of nitrogen in soil fertilization because not all of this element shown by chemical analysis is readily available for plant food, but this criticism seems to be based on a misconception of the nature of peat. It is true that only a part of the nitrogen shown by analysis can be immediately used for food by plants, but it is equally true that a chemical analysis of peat is not a fair test of its value as a fertilizer, and that the total quantity of potential soluble nitrogen formed and released by natural bacterial action from time to time after the peat has been applied to the soil is in the aggregate much greater than the percentage found in some commercial fertilizers. Fortunately all of the nitrogen in peat is not soluble

at one time or it would leach out and the potentially rich black peat soils of the country would be unproductive. Moreover, prepared peat, when added to some soils either directly or as an ingredient of commercial fertilizer, improves their physical make-up. Raw and strongly acid peat is also used in horticulture without nitrification in the cultivation of rhododendrons, orchids, blueberries, and other plants that require acid soil and are able to use nitrogen in organic form.

As so well summarized by the Bureau of Soils in a recent statement reviewing the fertilizer situation:

> The increasing scarcity, not to speak of the high prices, of organic ammoniates for fertilizers has been a source of real concern to the fertilizer manufacturer, for not only are these ammoniates in great demand as a source of nitrogen to make up their ideal of mixed fertilizer; but they are also depended upon to give the finished goods the proper mechanical texture. What to use as a conditioner is beginning to be a real problem. Dried ground peat is one of the natural materials that suggests itself.

Peat as a fertilizer ingredient is attracting wide attention and it is believed that its use for this purpose offers greater possibilities in this country than any other peat product.

Soil Bacteriology Presents Possibilities.

It has long been known that bacteria are potent agents in effecting chemical reactions in the soil and that they will not thrive without organic matter for food. Extensive study of the effect of inoculating soils with nitrifying bacteria is now in progress and the results thus far accomplished have been encouraging. Only a beginning has been made in the commercial application of bacteriology to soil fertilization, but it seems probable that further progress will be conducive of a large demand for peat as a culture medium.

Peat Soils Extensively Cultivated.

Peat, when properly treated, is one of the most fertile soil types in this country. Owing to the abundance in previous years of well-drained land that could be more readily tilled, the peat

and muck areas have been passed by, but with the rapid increase of our population and the advent of intensive soil cultivation the attention of agriculturists and others is now being directed to these neglected lands. There are about 15,000,000 acres of peat and muck land in the eastern section of this country and only about 750,000 acres, or 5 per cent of the total area, has been reclaimed for agricultural purposes.

Former Secretary Franklin K. Lane, in advocating the reclamation of the swamp and cut-over timber lands of the United States, said in substance in a statement for the press:

> There are approximately 200,000,000 acres of cut-over or logged-off timber land in the eastern half of the United States, and, overlapping to a certain extent the cut-over lands, some 80,000,000 acres of swamp land, located largely in the southeastern section of the country. To the ordinary observer the reclamation of these waste areas may seem difficult. The soil, however, is in many instances very fertile. For many years leafmold containing humus has been accumulating, and once the stumps have been blown out, and the land cleared of brush and brought under the plow, it is believed that these lands will prove among the most fertile of our agricultural resources. Like the Dismal Swamp in Virginia, or the Everglades in Florida, most of the swamp land in its present condition is unfit for human inhabitants. Consider this land cleared of its timber, adequately drained, and intensively cultivated and some idea of its possibilities for the production of food will be obtained.

The first attempts to use peat lands for the growth of crops were made in the older agricultural districts of the eastern States, notably New York and New Jersey. Some of the most productive farm lands in those States were formerly peat bogs and swamps. The truck farm of John N. Hoff, near Great Meadows, Warren County, N. J., the well-known onion farms of the Wallkill River Valley, Orange County, N. Y., and the Oak Orchard lands north of Batavia, N. Y., are reclaimed peat deposits. Thousands of acres of land in these States now under intensive cultivation consist of peat from 10 to 15 feet deep. Large areas of peat land in the Dismal Swamp district of Virginia and North Carolina are successfully devoted to the growth of potatoes, corn, wheat, and other crops. An average yield of more than thirty bushels of wheat per acre was obtained for

several years on the well-tilled farm of the Wallace Brothers, of Wallaceton, Norfolk County, Va. Extensive use of peat soils for crop cultivation is also made in Minnesota, Wisconsin, Michigan, Iowa, Illinois, Indiana and Ohio. Thousands of acres are already under cultivation and millions may be reclaimed by proper drainage and clearing. In fact, the economic future of entire counties in some of these States seems to be directly dependent upon the successful reclamation of peat bogs and swamps.

Peat Fuel Possibilities.

It is believed that in some parts of the country peat could successfully compete with other fuels for both domestic and industrial use. In recent years the increasing cost of producing coal and the failure of the operators to keep pace with the expanding demand have led to a general advance in price. Although peat fuel may not be widely produced in the United States as long as there is an abundant supply of coal, there are localities where conditions are peculiarly favorable and where peat has great potential value as a source of heat and power. Such localities are found in New England and some of the Great Lake States, whose climates are cold in winter, whose manufactures are extensive, and whose fuel requirements are large. These States contain large deposits of peat and are somewhat remote from coal fields. It is believed that peat can profitably be converted into fuel on a large scale in these States and a few others in the form of air-dried machine blocks, powder and gas.

Good Demand for Stock Food Peat.

Black carbonized peat has long been successfully used in the United States as a conditioner in stock food. It acts as an absorbent for the uncrystallized residues from beet and cane sugar refining, which, because of their viscidity, are otherwise difficult to feed. It is said that the peat also stimulates the digestive organs, contributes proteid substance and is an excellent substitute for charcoal.

A New Era Beginning.

More peat was produced in 1918 than in any preceding year and the value of the products exceeded $1,000,000. Despite the decline recorded for 1919, which it is believed was only temporary and was caused by the abandonment of a large peat fuel enterprise in New England in that year on account of a failure brought about by faulty engineering advice, the conclusion seems inevitable that the progress made during the last three years marks the beginning of a new era in the history of the American peat industry. Existing peat literature has been supplemented by much data relating to the deposits of the various States and extensive experimental work in peat technology has been conducted by governmental and private agencies. When the data that have been collected are published the peat operators will be prepared to forge ahead rapidly. This information will serve to brush aside the ignorance and prejudice that have long handicapped the legitimate operators and kept capital away, and soon to bring the peat industry to the important place it deserves among the industrial enterprises of the United States.

PRODUCTION OF PEAT IN 1919.

By K. W. Cottrell,
United States Geological Survey.

Production.

There was a decided decrease in both the quantity and value of domestic peat marketed in 1919, notwithstanding the hopes for that year awakened by the activity of the trade during 1917 and 1918 and the increasing demand for peat as fertilizer and fuel. This decrease may doubtless be attributed to the high cost of labor and the lack of transportation facilities.[1]

The total production of peat in the United States in 1919 was 69,197 short tons, valued at $705,532, an average price per ton of $10.20. This was a decrease of 35 per cent in quantity and of 33 per cent in value, but an increase of 44 cents in the price per ton, compared with 1918.

The accompanying table shows the output and value of peat since 1915. It includes air-dried and mechanically-dried peat, in which the moisture content is low, and does not represent raw peat, which contains a large percentage of moisture.

Peat Produced in the United States, 1915–1919.

Year.	Number of Plants Reporting.	Quantity (Short Tons).	Value.	Average Price per Ton.
1915	9	42,284	$ 288,537	$ 6.82
1916	13	52,506	369,104	7.03
1917	18	97,363	709,900	7.29
1918	25	107,261	1,047,243	9.76
1919	15	69,197	705,532	10.20

Peat Products.

Peat as Fertilizer and Fertilizer Filler.

In 1919, as in previous years, almost the entire output of peat was used as a direct fertilizer and for a nitrogenous ingredient

[1] The editor believes that this decrease is temporary and that it was caused by the abandonment of a large peat fuel enterprise in New England in 1919 on account of a failure brought about by faulty engineering advice.

of commercial fertilizers. The total shipment of peat for this purpose, reported from 13 plants, was 54,690 tons, valued at $557,240. This was 31 per cent less in quantity and 28 per cent less in value than that reported in 1918.

PEAT USED IN MANUFACTURING FERTILIZER IN THE UNITED STATES, 1915–1919.

Year.	Quantity (Short Tons).	Value.	Average Price per Ton.
1915	38,304	$258,447	$ 6.75
1916	48,106	336,004	6.98
1917	92,263	658,500	7.14
1918	79,573	775,313	9.74
1919	54,690	557,240	10.19

Peat as a Fuel.

Many attempts to manufacture fuel from peat have been made in the United States, and in 1918 it seemed, in the New England States at least, that peat fuel might soon establish a place for itself in the commercial world. The shortage and high price of coal may yet render it well worth the while of some of the large manufacturing and other interests to investigate the possibilities of peat fuel. Certainly the failure of peat-fuel enterprises can not be attributed to inability to dispose of the finished product but must rather lie in the lack of proper machinery, of labor, or of sufficient capital to carry the plant over a critical period.

For years the European countries have been utilizing peat for fuel. During the recent war the scarcity of coal in the British Isles and Canada, as well as on the European Continent, due to the absence of miners, necessitated the use of a substitute for coal. The disadvantages in the use of peat for this purpose, resulting from its bulky nature and the quantity of water it contains, may be satisfactorily overcome, as has been demonstrated by the manufacture of peat briquets. Peat has long been used for direct combustion. Rough blocks of peat are cut from the bog, allowed to dry in the hot sun, and are then ready for use. This is the more economical method of drying. It is reported that a large power station in Wiesmoor, Germany, has worked successfully for many years with air-dried peat, distributing electric power within a radius of 25 miles.

In Norway the Smolen Co., which owns peat bogs on Smolen Island, off the western coast, has a modern plant with six large machines for preparing the peat for market. Consul General Marion Letcher,[2] at Christiania, does not go into the details of the preparation of the peat, but he states that the company intends to extend its business to the manufacture of peat briquets for use by steamers and factories and that a coastwise steamship company serving the local trade in that vicinity has already used peat for its steamers, thus being able to keep up its sailings to the full extent while other local lines had to reduce their sailings because of the shortage of coal.

In Esthonia[3] peat has been tried as fuel on a narrow-gage State railway. The results were reported satisfactory, the principal difficulties encountered being the large space required for storing the fuel on account of its light weight and the fact that it had to be fed by hand instead of by shovel.

Consul Frederick Simpich,[4] on duty in Berlin, states that in Germany a society has been organized among 35 towns of Thuringia for the purchase and development of peat bogs lying in the Weser Basin, south of Bremen, as a source of fuel supply for these towns.

These are only a few of the many instances in which peat is being satisfactorily used as a fuel in foreign countries, and it is hoped that another year may show that the United States has taken its place among the countries successfully manufacturing from peat an acceptable substitute for coal.

Dr. C. D. Jenkins, president of the New Era Development Co., of Shirley, Mass., the only producer of peat fuel in New England who reported sales in 1919, writes that he has "invented and patented machinery for excavating, extracting water to 30 per cent, drying or carbonizing, and briqueting" the peat, and has sent very interesting samples of the briquets as they will be made when the machinery is in place.

No production of peat fuel was reported to the United States Geological Survey for 1915; an insignificant quantity was re-

[2] Peat production in Norway: Commerce Repts., June 29, 1920.

[3] Peat as railway fuel in Esthonia: Commerce Repts., Dec. 29, 1919.

[4] Commerce Repts, Apr. 17, 1920.

ported for 1916, but none for 1917. The production in 1918 and 1919 is given in the table on page 45, but in order that the returns of individual operators in 1919 may not be disclosed peat fuel, which was reported from only two plants, and miscellaneous products are combined.

Peat as Food for Stock.

Crude peat may not be considered a food for live stock, but properly prepared or carbonized peat has been used with good results in this country for the last 10 years and in European countries for more than 20 years as an ingredient in the preparation of commercial feeds for both live stock and poultry. Although carbonized peat is reported to contain nitrogen, phosphoric acid, and oil, all of which are important ingredients in the feed, it is not claimed to have any particular nutritive value. The effect is rather to stimulate the appetite and aid digestion, thus permitting the feeding of larger quantities of the fattening foods. The chief ingredients of the commercial feeds in which peat is used are cottonseed meal and molasses from beet or cane sugar factories. The mechanical influence of the peat in the use of molasses feeds is to prevent hardening and loss from evaporation. In addition to its value in commercial feeds, properly prepared peat or humus has proved to be a corrective and preventive in live-stock diseases.

The following extracts quoted from a letter of August 9, 1920, from Mr. John Wiedmer, president of the Wiedmer Chemical Co., which specializes in the manufacture of carbonized peat, are given as representing the arguments and conclusions of the manufacturer, himself an experienced student of peat:

My first knowledge and observation of this use for our special carbonized peat was in 1908–9. A manufacturer of sweetened stock feeds, of which black-strap molasses was the base, purchased a car of our product that we were preparing for the fertilizer trade. This looked very strange to me, and I visited him to ascertain what he was doing. He had visited Europe and knew of the uses of peat in some of the European countries, of which he told me. It was practically what Prof. Charles A. Davis of your department published in his Bulletin 16 [Bur. Mines], issued in 1911. Being personally acquainted with Prof. Davis,

I talked this matter over with him, and he confirmed what this manufacturer told me. I have never positively ascertained how these European countries using peat in stock feed prepared their peat, but found that the principal object was to add the peat in order to overcome the bad effects of molasses, such as scouring, belching, and bloating. Charcoal is one of the best preventives for this trouble, so we began to carbonize our peat by subjecting it to a very high degree of heat, practically making it a charcoal. We made careful chemical analyses of our finished product, as per copy herewith, and found that the manufacturers of molasses feeds could only use about 20 per cent of black-strap molasses without the use of a corrector, but with the addition of this product of ours feeding tests developed the fact that as high as 50 per cent. of black-strap molasses could be used. This, as long as molasses was cheap, was quite an item, and besides the feeders in the intense feeding district of the territories adjoining us called for a feed with our product in it.

Our contention, of course, is based on our special carbonized peat, holding in general that we have never offered our product as a food, but as a correcter and digester, a practical charcoal, and we contend that our material is as good for the purpose set forth as charcoal is.

Carbonization takes peat out of its raw state and changes its nature just as much as making charcoal from wood or cooking raw products changes their nature.

I call your attention to analyses by Dr. H. E. Wiedemann; you will note he finds about 18 per cent of protein in our material. The pepsin test shows that this is about 30 per cent digestible. Some of the State chemists objected to this high protein content, holding that manufacturers of feed took advantage of this in the formula of their feed. But as the manufacturer uses less than 5 per cent of the peat in his feeds the protein thus applied would be very slight. The moisture of 10 per cent shown is not actual water, but more of a humic acid. The other analysis is of the ash content of our peat. . . . The actual sand in the material is very slight.

Analysis of Peat.

Protein	17.84
Carbohydrates	35.50
Crude fiber	15.01
Fat	1.10
Moisture	10.06
Ash	20.49

Analysis of Peat Ash.

Silica	51.66
Iron oxide	4.27
Alumina	9.15

Calcium oxide	21.43
Magnesia	2.74
Sulphur trioxide	8.04
Phosphoric acid	1.57
Potash	.60
Soda	.51

Although there is evidence that the use of carbonized peat is desirable rather than otherwise in the manufacture of some kinds of commercial stock feeds, the objections made to its use in some of the States might well tend to discourage operators in these localities. Nevertheless the total quantity of peat used in the manufacture of stock food in 1919 was 6,402 short tons, valued at $98,940, an average price per ton of $15.45. Though this quantity was ten per cent less than that used in 1918, it was greater than in any other previous year, according to the records of the Geological Survey. The average price per ton increased 38 cents.

PEAT USED IN MANUFACTURING STOCK FOOD IN THE UNITED STATES, 1915–1919.

Year.	Quantity (Short Tons).	Value.	Average Price per Ton.
1915	3,980	$30,090	$7.56
1916	4,300	32,250	7.50
1917	5,100	51,400	10.08
1918	7,096	106,935	15.07
1919	6,402	98,940	15.45

Peat as a Source of Alcohol.

Erwin W. Thompson, commercial attaché at Copenhagen, Denmark,[5] reports that successful experiments have been made in extracting alcohol from peat. The peat is boiled under pressure with sulphuric acid and a sugar solution is obtained and some residual products. After the acid has been neutralized with lime, the sugar solution is made into alcohol, and the peat residue is collected and made into briquets for fuel.

The Swedish Government has agreed to the building of a factory on the understanding that the shareholders in the company should have the right to purchase and use the alcohol for their motor boats, trucks, and private automobiles irrespective of Government prohibitions and maximum prices.

[5] Commerce Repts., Jan. 8, 1919.

Imports and Exports.

The imports of peat during 1919 were 464 tons, valued at $16,345, and consisted of peat moss. The quantity was so small that records of the countries from which it was received were kept only at the port of entry. No exports of crude peat or peat products were reported in 1919.

Peat Moss Imported for Consumption in the United States, 1916–1919.

Year.	Quantity (Short Tons).	Value.	Average Price per Ton.
1915	7,514	$48,142	$6.41
1916	3,042	27,859	9.16
1917	506	4,966	9.81
1918	.....	.....	.....
1919	464	16,345	35.23

Summary.

Peat and Peat Moss Used in the Manufacture of Peat Products in the United States in 1918 and 1919.

Kind of Product.	Production.		Imports.		Consumption.	
	Quantity (Short Tons).	Value.	Quantity (Short Tons).	Value.	Quantity (Short Tons).	Value.
1918.						
Fertilizer and fertilizer ingredient	79,573	$775,313	.....	.....	79,573	$775,313
Stock food	7,096	106,935	.....	.....	7,096	106,935
Fuel	20,567	164,745	.....	.....	20,567	164,745
Miscellaneous	25	250	.....	.....	25	250
	107,261	1,047,243	.....	.....	107,261	1,047,243
1919.						
Fertilizer and fertilizer ingredient	54,690	557,240	.....	.....	54,690	557,240
Stock food	6,402	98,940	.....	.....	6,402	98,940
Fuel and miscellaneous products	8,105	49,352	.....	.....	8,105	49,352
Moss	.....	.....	464	$16,345	464	16,345
	69,197	705,532	464	16,345	69,661	721,877

Distribution of Peat Plants.

The 15 plants reporting production for 1919 were distributed as follows: California 2, Florida 1, Illinois 2, Indiana 1, Massachusetts 1, New Hampshire 1, New Jersey 3, New York 3, and North Carolina 1.

New Jersey, the leading State in the production of peat, reported sales of 27,743 tons, valued at $267,567, an average price per ton of $9.64.

The New York plant reporting the largest production for 1918 was idle during 1919, and the operations of the three producing plants were very small.

Word has been received that the Alphano Humus Co., one of the largest producers of peat fertilizer and fertilizer ingredients in the United States, with plants in Marion County, Fla., and Warren County, N. J., expects to enlarge its fertilizer plant in New Jersey and to build a larger plant in the near future in Florida for the production of organic ammoniate and sulphate of ammonia.

Producers of Peat in the United States.

The following individuals and companies reported to the Geological Survey that they produced crude peat or peat products in the United States in 1919:

Alphano Humus Co., Whitehall Building, New York, N. Y.

American Peat Products Co., Morrison Ill.

Chapman, I. S. & Co. (Inc.), 937 Third Street, San Bernardino, Calif.

Cole, Norvin G., Hopewell Junction, N. Y.

Commercial Humus Co., 903 Ordway Building, Newark, N. J.

Day, James H., 35 South Street, Milford, N. H.

Hyper-Humus Co., Newton, N. J.

McElhone, Asa, Fishkill, N. Y.

New Era Development Co., 110 State Street, Boston, Mass.

Nitro-Phospho Corporation, 519 East Franklin Street, Richmond, Virginia.

Riverside Orange Co. (Ltd.), Arlington Heights, Riverside, Calif.

St. Joseph Humus Co., Van Wert, Ohio.

Sims, Alfred F., Sag Harbor, N. Y.

Wiedmer Chemical Co., Pierce Building, St. Louis, Mo.

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NEWS OF THE DOMESTIC INDUSTRY.

Connecticut.

Commercial Production Expected Soon.

Edward A. Beals, of Hartford, Conn., has made many energetic attempts to establish a peat industry in Connecticut, but, although the State contains large deposits and a few plants have been erected, there is no industry in a commercial sense. It is believed that the failures may be ascribed to a lack of accurate information concerning the quality of the deposits, to insufficient capital, and to incompetent engineering advice. Several years ago a peat plant was installed by the Connecticut Co., a subsidiary organization of the New York, New Haven, & Hartford Railroad Co., at its Burrville power house, but after several trials the project was abandoned. A. N. Pierson, a florist of Cromwell, Conn., also attempted to substitute peat for coal in heating his greenhouses, but the raw peat selected contained an undue proportion of silicia which melted in the furnace and interfered with the draft. However, it is understood that a further attempt is being made to produce peat fuel commercially in Connecticut and it is hoped that the project will be successful. The best opportunities are presented by the peat marsh near the Davis Brick Yard at North Haven, the West Bog near Waterbury, the Orange Bog near Ansonia and New Haven, and the Canan Bog, as well as several smaller deposits on the Connecticut side of the boundary line between that State and Massachusetts.

Good Possibilities for Large Peat Industry.

Because of the increase in the cost of nitrogen for use in compounding fertilizers, the growing need for humus in the depleted soils of the State, and of the importance of peat for these purposes, it seems that the deposits are of great potential value to the farmers and the general welfare of Connecticut. Unless some fundamental change is made in the administration

of our railroads so as to provide adequate transportation facilities, it seems further that the State of Connecticut may suffer from a shortage of coal during the winter months that will become cumulative in future years. If there is any State where peat can be successfully produced and marketed as fuel it is in Connecticut, where the winters are long, where there are no known coal fields, and where, on account of extensive manufacturing industries, large quantities of fuel are needed.

Enright Claims to Make Commercial Gasoline from Peat.

One of the most unique claims that has ever been made respecting the products that may be made from peat has recently been put forth by Louis Enright, of Farmingdale. According to Enright, gasoline in commercial quantities may be obtained from peat by destructive distillation at a price that is economic. A demonstration was recently made by him before the Town Board of Hempstead at which a yellowish fluid alleged to be gasoline was obtained by the use of his process and equipment. A sample of the fluid was taken by the board for the purpose of submitting it to a chemist for examination. It has been said that the board may later entertain a proposition from the Enright Gasoline Corporation to lease some of the municipal peat land on a royalty basis. At present there is no known commercial substitute for gasoline distilled from crude petroleum or extracted from natural gas, and according to the Bureau of Mines no process in immediate prospect for obtaining gasoline from other substances that promises to be successful. Several attempts have been made to produce fuels that would take the place of gasoline in internal combusition engines but the cost of production proved prohibitive.

State Survey Being Made.

The greatest handicap suffered by prospective producers of peat in Connecticut has been the lack of data relating to the location, quantity, quality, and uses of the local deposits. Several years ago a report was prepared by the Geological and Natural History Survey but it never was published because the manu-

script, which had been submitted to Professor Davis, of the Bureau of Mines, for review, could not be found after his death. It now seems that the needed information may soon be made available as an agreement was recently reached by the survey and C. C. Osbon, formerly in charge of peat surveys for the United States Geological Survey, for the preparation of a report by him on the deposits of the northern counties. It is possible that the agreement may later be revised to include the entire State. Mr. Osbon is now collecting samples and other data for the report, which he has promised to submit by June 1, 1921.

Florida.

Alphano Humus Co. Active.

Robert Ranson, of Pablo Beach, and the Florida Peat Products Co., of Meadows, manufactured peat fertilizer commercially in Florida for many years. However, in 1918, because of the shortage and high cost of labor, the former discontinued operations and the plant of the latter was purchased and has since been operated by the Alphano Humus Co., of New York, N. Y.

Florida, like Minnesota, Maine, and Massachusetts, presents good opportunities for the growth of peat fuel and fertilizer industries. Attention has been directed by E. H. Sellards, of the Florida State Geological Survey, to the possibilities of Florida peat as a source of power.

Illinois.

Illinois Has Substantial Industry.

For many years Illinois has contributed a substantial proportion of peat and muck to the nation's output. The Wiedmer Chemical Co., of St. Louis, the largest and most successful producer of stock food peat and one of the largest producers of fertilizer peat in the United States, as well as other companies, operates in Illinois. The deposit from which the Wiedmer Chemical Co. obtains its crude material is located in Mason and Tazewell counties. The American Peat Products Co., whose plant is located on a deposit near Morrison, is another important producer of peat fertilizer and stock food in Illinois.

Many large peat deposits in Illinois are well situated with respect to transportation facilities and to the commercial fertilizer plants, and Illinois is one of the great agricultural States. Because of these advantages and of the good quality of the peat as a source of fertilizer material, it is believed that additional plants erected for the production of peat as an ingredient of commercial fertilizer would, if properly managed and efficiently operated, be successful.

Sedges are cut from some of the peat deposits of Lake County and used for packing material in ice and cold storage plants or sent to Chicago and employed in packing fragile articles for shipment. Many areas of peat land have been reclaimed for crops, but only a beginning has been made and there are thousands of acres of potentially productive peat and muck land that will eventually be drained and used for farming. Although several attempts have been made to produce peat fuel in Illinois, none has ever been manufactured commercially. On account of the abundance of coal in that State prospects for the development of a peat fuel industry are not promising.

Indiana.

Peat Production Important.

The contribution of Indiana to the output of peat in the United States consists of fertilizer produced from deposits near Ft. Wayne and Lakeville by the Virginia-Carolina Chemical Co. and the St. Joseph Humus Co. The production of the former company was used in the manufacture of commercial fertilizer, but the latter's production is sold to florists and golf clubs and used as a direct fertilizer for potting plants and lawn cultivation. The plant of the Virginia-Carolina Chemical Co. at Ft. Wayne was destroyed by fire in 1918, but will probably be rebuilt. As the peats of Indiana are high in nitrogen the production of fertilizer should increase.

Large areas of peat land in this State are cultivated, the principal crops being onions, celery, peppermint, and corn. Several of the large deposits in northern Indiana contain fibrous peat suitable for packing material and stable litter. It is said that

large quantities of peat as well as peat moss have been produced and sold to florists. Because of the abundance of coal it is not probable that peat fuel could be profitably produced in Indiana.

Iowa.

Iowa Peat Unsuited for Fuel.

Several attempts have been made to produce machine peat fuel commercially in Iowa, but they were unsuccessful. Although the deposits selected were among the best in the State, the ash content of the peat is too high for good fuel. A peat fuel plant was operated for a short time at the Goose Lake deposit near Fertile, Worth County.

Maine.

Conditions Favorable for Peat Operators.

Conditions in Maine are probably more favorable for the profitable production of peat fuel than in any other State. The climate is cold in winter and the State is remote from coal mines and contains large deposits of good peat. Experimental work has been done on the Garcelon bog, about two miles east of Lewiston, Androscoggin County, and in 1918 a small quantity of peat from this deposit was used in the manufacture of machine peat fuel, which was sold to local consumers. Other prospective producers state that they are awaiting the result of the experimental work of the Canadian Government at Alfred, Ontario, prior to erecting plants. Peat fertilizer has also been produced at bogs near Mechanic Falls, Androscoggin County. There is some high-grade peat moss in Maine that could be used for surgical dressing. The lower grade moss, as well as the fibrous peat, could be employed for packing material and stable litter.

Massachusetts.

Considerable Production and Much Activity.

Peat has been produced from deposits near East Lexington, Framingham, Peabody, North Adams, Norwood, Shirley, and Walpole, Mass., and used for many years. The principal operator is the New Era Development Co., of Boston, Mass. Dr. C.

D. Jenkins, who is associated with that company, has been one of the most active peat producers in Massachusetts for many years and has designed and patented peat fuel machinery. Prospects for the development of a large peat industry in Massachusetts are good. Many deposits are located near the large cities and are readily accessible. It is reported that very little anthracite coal is available in Plymouth this winter and that some citizens have provided themselves with peat.

The Tide Power Co., of Boston, Mass., purchased an eight-acre tract of peat land a few months ago and have been engaged in making surveys and preparing to construct a plant for the generation of electricity from peat. The Saugus River Peat Products Co., of Lynn, Mass., are reported to have recently acquired a large tract of peat land near Lynnfield for the purpose of erecting a modern peat fuel plant. Much attention has lately been given by the people of Amesbury to the prospect of using the peat from a large deposit adjoining the Haverhill Road near the center of the town to supplement the coal supply. Specimens of the fuel are on exhibition in the town hall. The peat is said to be about 14 feet in depth and of good quality for fuel. Attempts have been made to interest the municipal authorities in the subject.

Michigan.

No Peat Industry in Michigan.

The peat industry of Michigan has never reached large proportions. From 1900 to 1917 attempts to manufacture peat products were made by the American Peat & Fuel Co., and its successor, the Pilgrim Paper Co., both of Capac; the Bancroft Peat Fuel & Cement Co., of Bancroft; Carl G. Kleinstueck, of Kalamazoo; the Michigan Peat Co., of Eaton Rapids; the Michigan Peat & Marl Co., of Grand Rapids; the Montgomery Peat Fuel Co., of Montgomery; and the Wolverine Peat Co., of Vicksburg. Only small quantities of fuel, paper, and cardboard were produced, and for various reasons all the projects were abandoned.

Although peat in commercial quantity has not recently been produced in Michigan, large scale experimental work has been

done by Louis P. Haight, of Muskegon, who proposes to produce bacterized peat and use it in tilling sandy soil. A large peat fertilizer plant was erected by the Fertile Chemical Co., at Chassell, Mich., in 1918, but so far as can be ascertained, it has not yet reached the commercial stage. It is reported that large crops are annually raised on peat soils in Michigan.

To meet the demand for peat fuel machinery plants have been designed in Michigan by the C. A. Willmarth Co. and J. Campbell Morrison, of Detroit, and by Herbert Garnett, of Grand Rapids. It is reported that attempts are being made to produce peat fuel by the Morrison process at Chelsea and Capac.

Minnesota.

Interesting Developments in 1920.

Although Minnesota contains a large proportion of the workable peat in the United States, little was done to use it commercially prior to 1920. However, a little hand-cut peat has been produced by farmers for use in their own homes for many years and large areas of peat land are cultivated. What promises to be the largest peat fuel development in the United States was begun in 1920 at Minneapolis. The following in substance is an excellent discussion of the project that appeared in the September 5 edition of the *Minneapolis Journal*:

Peat Mined and Burned in Attempt to Solve Fuel Problem.

Minneapolis, Minn. Peat is being mined in Hennepin County and burned in the heating and power plant of the Phoenix Building to determine whether it can be used in competition with coal. The peat is taken from the bog three miles from the city limits at the rate of about 100 tons per day. The Hennepin Atomized Fuel Co., which is producing the peat, is building a pulverizing plant with a proposed daily capacity of 480 tons. When the plant reaches the commercial stage it is planned to sell the peat for use in furnaces equipped to burn pulverized fuel. The company was organized two years ago and the plant was started in February, 1920. The deposit from which the peat is taken is estimated to contain nearly one half million tons. Herbert Garnett designed the plant. At present the peat is being pulverized at the Engineering Department of the University of Minnesota.

The Phoenix Building is the only office building in the city equipped to burn powdered fuel. It is said that the Radisson Hotel, the Plymouth Building, the Nicollet Hotel, Security Building, and Soo-First National Building all have been examined with a view of installing furnaces in which powdered fuel may be burned.

Officers of the company say that in the Phoenix Building tests it had been found that pulverized peat is 90 per cent as efficient as pulverized coal and twice as efficient as mine run coal when hand stoked. They said the tests showed that 105 pounds of peat did the work of 96 pounds of the best pulverized coal and that a pound of peat would convert 9.9 pounds of water into steam where coal under hand stoking will convert from 5 to 6½ pounds.

Pulverized coal was used in the Phoenix plant all last winter in competition with hand stoking and when 18,000 pounds of mine run coal were required on a midwinter day, 8,800 pounds of pulverized coal did the same work on a day of the same average temperature. Later the peat tests were made in comparison with pulverized coal.

The tests have been directed by C. L. Bohannon, combustion engineer of Canton, Ohio, who came to Minneapolis to test the plants in view of equipping them for pulverized coal. He had never burned peat before coming to Minneapolis, and the Minneapolis tests are the first ever made under strictly industrial conditions and using pulverized fuel exclusively.

After yesterday's tests Mr. Bohannon said they fufilled the prediction of Henry W. Hindshaw, of the staff of the State's mineral department, who in a report to J. A. O. Preus, State Auditor, said, peat properly prepared, would fulfill all of the State's industrial needs and could free the State from dependence on eastern mines.

Enough to Last 1,000 Years.

E. K. Soper in his book on peat, published by the university, said the State had 7,000,000 acres of peat bogs with a potential supply of 6,558,000,000 tons of dry peat, enough to last 1,000 years at the present rate of fuel consumption.

Mr. Soper's survey showed many large bogs in Hennepin County, including the one now being used.

While enough peat cannot be taken out this fall materially to help the fuel situation, F. E. Bryan, president of the company, said all the digging machines that can be made will be put in the Hennepin County bogs next year. The Minnesota field is to be developed first. All peat taken out this summer and fall will be ground in the new plant and coal will also be ground this winter. It is the plan to grind peat only when the digging is in full sway. The present bog will be exhausted in four years. There is peat, however, near every manufacturing town in the State.

The peat burning tests are to be continued every afternoon in the Phoenix Building and they are open to all engineers and others interested in them.

In the April number of the JOURNAL OF THE AMERICAN PEAT SOCIETY the statement was made that the Hennepin Atomized Fuel Co. had acquired ten acres of peat land in the northeastern section of Minneapolis. This tract is being used merely as a site for the pulverizer plant. In August, 1920, the company was negotiating for a 13,000-acre tract upon which it was planned to operate ten machines.

LARGE POSSIBILITIES FOR PEAT INDUSTRY.

Minnesota peat is also well adapted to the production of machine peat fuel. A large number of the deposits are well located with respect to transportation facilities and market and conditions are more favorable to the growth of a peat fuel industry than in many of the other peat States. The Hamm Brewing Co. of St. Paul, Henry W. Hindshaw, of Hibbing, and the National Peat Products Co., of Minneapolis, have conducted experiments with peat fuel.

The possibility of using peat in the manufacture of producer-gas and by-products has also attracted some attention in Minnesota. The iron-mining districts in the northern part of the State lie adjacent to vast peat deposits and are large users of power generated with coal brought in from other States. The suggestion has been made that peat be used in the iron ore industry of Minnesota for generating power, for drying, washing and calcining, for a binder in briquetting, and for the manufacture of coke and charcoal in smelting.

In order to show the value of peat to the State the Mineral Land Department conducted a class in peat production and utilization and demonstrated a process for converting peat into powder and gas at the State Fair in September. Henry W. Hindshaw was in charge.

The peat deposits of Minnesota are also an important source of nitrogen for use in fertilizers. The nitrogen content of Minnesota peat is relatively high and the peat could be used as a

direct fertilizer or as a nitrogenous ingredient of commercial fertilizers.

Another important value of the deposits lies in their reclamation for use as a crop soil. In fact the settlement and industrial future of entire counties in the northern part of the State seem to depend to a large extent upon the drainage of the peat land and its use in the growth of crops. Although, as pointed out by Alway, the agricultural use of peat land is limited, it seems certain that more and more peat will be reclaimed each year for farming. The excellent results obtainable on peat land properly treated with phosphate and potash were shown to the Northwest Development Committee of the Minneapolis Civic and Commerce Association on a trip of inspection to the Coon Creek peat experiment field and the Simon Kruse farm in Anoka County in July, 1920.

Treatment of both sandy and peat lands was demonstrated by Dr. F. J. Alway, chief of the division of soils, University of Minnesota, who showed the business men an oat stand on peat soil at the Kruse farm that will yield 75 bushels to the acre. Peat soil, rich in vegetable matter and lime, must be treated with phosphate and potash, he explained, while sandy soil, lacking lime and humus, must have these ingredients added.

Fires Destroy Much Peat.

In spite of the value of peat to Minnesota as shown above large deposits are annually allowed to burn in the field. During the summer of 1920 some of the most destructive peat fires in the history of the State occurred in Beltrami and Roseau counties. Several thousand acres are reported to have been burned over in the area north of Red Lake and south and southeast of the Lake of the Woods. According to the State Forester, W. T. Cox, the fires are started by irresponsible persons, despite State laws forbidding it, and in some instances by landowners who think the fires will reduce the cost of clearing. Violaters of the law should be held strictly accountable for their actions as the loss of property is great and deposits of peat that it has taken thousands of years to form may be destroyed in a few days. The

statement has been made that the fires in some instances benefit the soil by leaving deposits of potash. It is not believed that the small advantage that might accrue in this way would offset the loss of the peat. It was reported in September, 1920, that the fires had been extinguished by rain and the efforts of the rangers and citizens.

New Hampshire.

New Hampshire Contains Peat Moss.

The contribution of New Hampshire to the national output of peat products consists of peat moss gathered from bogs near Milford, Hillsborough County, and sold to florists and nurserymen. Although peat fuel was made in Rockingham County several years ago, there is now no commercial production. New Hampshire contains several peat deposits of commercial extent that could be used for the manufacture of machine peat fuel for local consumption.

New Jersey.

Largest Production in the United States.

For many years New Jersey has been the principal peat producing State in this country, the largest operator being the Alphano Humus Co., of Warren County. The other producers are the Commercial Humus Co., of Newark, and the Hyper-Humus Co., of Newton. Although peat is found in Bergen, Essex, Hudson, Mercer, Middlesex, Morris, Passaic, Somerset, Sussex, Union, and Warren counties, the entire output of 1918 was produced by three operators in Sussex and Warren counties. Peat soils are used in some parts of the State for truck farming. No peat fuel is produced, and it is doubtful whether peat could compete with Pennsylvania coal at present prices.

Industry Makes Progress in 1919.

The peat industry in New Jersey grew somewhat during 1919. This industry, in which New Jersey leads all other States, made its most rapid growth during the war. Its continued growth in New Jersey during 1919 is significant as an indication of its establishment on a permanent basis.

Native peat is a dark brown or black substance, consisting chiefly of decayed vegetation and water. When dried it is used in Europe as a fuel where coal is scarce, but in this country it is used principally as fertilizer for special purposes and as a filler for certain commercial fertilizers because of its nitrogen content. It is also used to a less degree for packing, for medicinal purposes and in the manufacture of stock feed.

Last year the total of peat produced in New Jersey was 27,743 short tons, valued at $267,567, while in 1918 the total was 26,218 short tons, valued at $264,822, an increase in tonnage of 1,525 and in value of $2,745, according to figures issued by the State Geologist, Department of Conservation and Development, working in co-operation with the United States Geological Survey.

New York.

New York Important Peat State.

Peat fertilizer is produced in New York by N. G. Cole, of Hopewell Junction, Asa McElhone, of Fishkill, and to a small extent by A. F. Sims, near Sag Harbor. The peat soils of New York are intensively cultivated and some of the most productive truck farms in this country consist of reclaimed swamp land in that State.

Although cut peat is used by farmers throughout the State and several attempts have been made in recent years to manufacture machine peat, there is no peat fuel industry in New York. As the State is supplied with coal from mines in Pennsylvania, the prospects for the profitable production of peat fuel are not as good as they are in some of the New England States. The most favorable deposits are located in the Cicero Swamp north of Syracuse and in the Wallkill River Valley.

It has recently been reported that Juniper Swamp, an interesting peat deposit lying between Jamaica and Flushing, is to be drained. A sewer for this purpose has been extended from Seventy-Second Ave., Flushing, in order to remove the tendency of the swamp to breed mosquitoes. About a century ago the deposit was used as a source of fuel by the poorer classes of the vicinity. It is hoped that the peat will be used commercially when it has been drained.

North Carolina.

Prior to 1919 a small quantity of peat was produced by the Atlantic Humus Co. from a deposit 250 acres in area near Newbern, Craven County, and sold to a company in Richmond, Va., for the manufacture of bacterized peat. It is understood that the deposit was bought by the latter company in February, 1919. The Nitro-Phospho Corporation is the name of the operator. North Carolina contains a large quantity of good fertilizer peat.

Ohio.

Many of the peat deposits of Ohio are located near cities and towns and are readily accessible by railroad. In spite of this advantage there is little peat produced in Ohio, though large areas of peat land are cultivated. Because of the abundant supply of coal in this State it seems that peat fuel could not be successfully produced and that the greatest value obtainable from Ohio peat is its use for agricultural purposes.

A. P. Dachnowski, of the Bureau of Plant Industry, United States Department of Agriculture, recently made a survey of the deposits in the vicinity of Meyers Lake and Hartville. According to reports he stated that the peat was of good quality for fertilizer and fuel. At present the deposits are used for the cultivation of celery, onions, and other trucks crops.

Pennsylvania.

Although peat fuel could not compete with coal in Pennsylvania, that State contains peat of value as a source of nitrogen for use in soil fertilization. A small quantity of peat fertilizer has been produced annually from a deposit near Espy, Columbia County, for many years. Pennsylvania also contains large areas of peat moss that could be used for packing material and stable litter. Small areas of sphagnum moss suitable for surgical dressings are found in a few of the bogs, but according to the State Geological Survey *Sphagnum papillosum,* one of the best species for medical use, does not occur there. It is said that fibrous peat and peat moss are used for bedding in some of the underground stables in the Wilkes-Barre anthracite coal-mining district.

Rhode Island.

Prospects for the growth of a peat industry in Rhode Island are not promising. Some of the muck in that State might be advantageously used for composting with manure or for increasing the humus content of soils deficient in this plant requirement. The State contains relatively little accessible peat suitable for fuel. The reclamation of the peat land for agricultural use seems to be the most promising prospect.

Vermont.

In former years peat fertilizer was produced from deposits in Pearl Swamp, Grand Isle County, and on the Booth estate, near Vergennes, Addison County. However, in recent years no peat fertilizer has entered the market from Vermont. The nitrogen content of Vermont peat is relatively high and its deposits are therefore worthy of careful experiment as a source of fertilizer material.

Although John Webster, of Franklin, used peat fuel extensively for many years and a deposit on the Jewett farm, near Highgate, Franklin County, was purchased several years ago as a prospective site for a peat plant, no peat fuel has been produced commercially in the State. Because of the lack of market it is doubtful whether peat could be profitably produced and sold on a large scale in Vermont. However, there are numerous small deposits scattered throughout the State, from which farmers might cut their own fuel.

Cranberry Marsh, which is about 200 acres in area, contains a large quantity of good peat moss that would make stable litter and packing material for florists.

Virginia.

Large areas of peat land in the Dismal Swamp district of Virginia are used for the cultivation of crops. Many of the peat deposits of the Dismal Swamp are rich in nitrogen and humus, are readily accessible by water and railroad, and are close to the fertilizer plants of Norfolk and the trucking region of Virginia. It seems, therefore, that peat fertilizer plants in this locality should be successful.

It is understood that in 1860 a peat fuel plant was erected near Wallaceton, Norfolk County, but that on account of economic conditions which arose with the outbreak of the Civil War it was unsuccessful and the machinery was dismantled.

The Lake Drummond Canal & Water Co., which operates the Dismal Swamp Canal, and is a large owner of peat land in the Dismal Swamp, became interested in the production of peat fertilizer in the early part of 1920, but it is not known whether a plant has been erected by them in the Dismal Swamp district.

Wisconsin.

Much Interest Shown in Peat Deposits.

Hand-cut peat has long been used by the farmers of Wisconsin. Several attempts have been made to produce machine peat fuel commercially and though they did not succeed because of technical inexperience, it was conclusively demonstrated that Wisconsin peat is well suited for fuel. Peat soils are extensively used for the growth of crops and peat has been used to a small extent for fertilizer. Small quantities of peat moss and marsh grass are annually sold to florists and matting companies. It is reported that gas and paper have also been made from peat in Wisconsin, but the plants never advanced beyond the experimental stage. So far as can be ascertained no product of peat, except crops grown upon peat soil and small quantities of peat moss and marsh grass, have been produced and sold in Wisconsin. Although the use of Wisconsin peat for farming and fuel probably offers the most promising possibilities, the peat deposits of that state are well adapted for the production of stable litter, packing material, cardboard and paper.

It is reported that a company known as the Appleton Peat Products Co. was organized a few months ago for the production of peat fertilizer and fuel from a deposit known as Center Swamp. C. A. Willmarth is the Vice President and General Manager. The deposit acquired by the company is about 360 acres in area and has been examined geologically by Professor R. M. Bagg, of Lawrence College, who reported that it was of good quality.

Other States.

Delaware, Maryland, South Carolina, Georgia, Alabama, Mississippi, Louisiana, Texas, Washington, Oregon, and California, contain peat and muck that could be used for crop cultivation or for fertilizing soils that are deficient in humus and nitrogen. Peat was produced in Georgia in 1918 by the Southern Humus Co. and the Tifton Guano Co., at Pineora and Tifton, respectively. The work was largely experimental, but it is said that the market for peat in Georgia is excellent and that machinery was installed in these plants to produce a large quantity of peat fertilizer in later years.

Peat land is used in Washington for truck gardening and cranberry culture and it is said that small quantities of peat fuel and peat moss are also produced. Immense quantities of high-grade moss that might be profitably produced and sold to florists and nurserymen is found in both Washington and Oregon.

Peat was produced by the Riverside Orange Co., Ltd., and by I. S. Chapman & Co., Ltd., in San Bernardino County, Calif., in 1918 and 1919, and used in the cultivation of citrus trees. It is understood that these companies are still operating. One of them enriched its product by treatment with nitrifying bacteria. Peat is said to be gaining favor in the citrus industry of California and it is reported that two new plants have recently been erected. Attempts have been made by the Pacific Peat Fuel Co., Ltd., of San Francisco, to produce peat briquets by the Herbein process, but none of these briquets has yet entered the market, so far as has been learned from that company.

NEWS OF THE INDUSTRY IN FOREIGN COUNTRIES.

British Empire.

Print Paper Made from Peat in England.

Peat, long used in Great Britain and Ireland as a substitute for coal, now gives considerable promise of supplementing the supply of wood pulp for the manufacture of paper. Experiments recently conducted in Manchester, England, demonstrated the possibility of making a usable grade of newsprint from bleached peat pulp, and the inventor displayed samples of other papers, of various tints, suitable for wall papers, wallboard, wrapping paper, etc. For better grades of stock, it is proposed to mix the peat with wood pulp.—*Brooklyn Times,* Aug. 28, 1920.

Peat Yields Gum and Oil in New Zealand.

Over thousands of acres the soil of the buried kauri-pine forest of the North Auckland Province of New Zealand not only contains masses of kauri gum but is soaked with oil. In December last a plant for extracting the oil was put in operation at Redhill, and is thought to be the beginning of an important industry. Extraction of oil from the so-called kauri-gum peat is said to be cheaper than that of gum. A ton of peat, containing ten per cent of gum yielded 64 1-3 gallons of oil; this supplies motor spirit, a solvent oil, a turpentine substitute, and paint and varnish oils.—*Newark News,* Aug. 18, 1920.

Scottish Peat Fuel Factory.

The following is a description of the process used in the production of peat fuel at a plant near Dumfries:

The system used is a modification of the Ekenberg wet carbonizing process. The peat, containing as high as 93 per cent moisture, is first made into pulp and then forced under high pressure through pipes of 2-inch steel tubing heated by steam jackets.

After the peat is wet-carbonized it is forced under a pressure of 120 pounds per square inch into filter presses, where the water content is reduced to 25 per cent. The peat cakes are next pulverized and the dust is blown through boiler flues and dried to 2 per cent moisture. It is then pressed into briquets weighing from 0.5 to 1.5 pounds with a calorific value of 11,200–12,500 B. t. u. per pound.—*Chemical Eng. and Mining Rev.*, 1919, Vol. 12, pp. 76–9.

Denmark.

Growth of Peat Industry.

Everything possible is being done to increase the internal production of peat. There is practically no wood available for fuel in Denmark, but there are excellent and extensive peat moors. In 1913 the production of peat amounted to 200,000 tons. In 1918 it was increased to 2,000,000 tons, and in 1919 the amount dropped to 1,500,000 tons, partly because minimum prices were fixed by the Government which discouraged production, and partly because it was necessary to cut the peat in less favorable localities and at a greater labor cost.

The price in 1918 was 40 crowns ($10.72 normal rate) per ton, which brings the value of the total production to 80,000,000 crowns ($21,440,000). This peat, it is estimated, took the place of 126,000,000 crowns (about $33,768,000) worth of coal, thus sparing the consumer 46,000,000 crowns (about $12,328,000). Two and one-half tons of peat are considered the equivalent of one ton of coal. Although the peat industry has been carried on with great risks and the earnings have been small, it would seem that this industry will continue to be more important than before the war, at least until conditions for fuel import become definitely better.

This year the Government has removed all restrictions on prices, and it is expected that the amount of peat produced will be once more about 2,000,000 tons.—*Commerce Reports*, Sept. 16 and Oct. 11, 1920.

Peat Established as Fuel.

It Is Employed To Furnish Power For Many Big Industries.

In 1919 peat established itself as a fuel more firmly than ever in Denmark. It is used now by nearly all the industries, by the private railroads and in the country districts, where it is practically the only fuel. Twelve million peat bricks were taken from the marshes in the Odense district alone in 1918. The electrical works of Svendberg have successfully used peat gas instead of petroleum. As a locomotive fuel it proved to have some disadvantages, requiring a larger boiler and giving off more sparks.

Peat producers have complained that the Government's maximum price on this article has made its manufacture difficult. There have been a number of failures. However, the quality of peat has been greatly improved during the last five years, and more has been learned of its possibilities. It will, therefore, undoubtedly figure much more than previously as an economic factor in Denmark.—*New York Sun.*

France.

French Congress Subsidizes Peat Industry.

The extent to which the French Government has gone in aiding private industry to develop the peat deposits and thus augment needed fuel supplies is shown by the following excerpt translated from Bulletin 2 of the Union of Peat Operators of France:

An appropriation of 500,000 francs was made for the purpose of aiding peat producers in 1919 and a similar sum will probably be allotted for 1920.

The appropriation for 1919 was used in the following manner:

1. The sum of 12,000 francs was given as a subsidy to one of the professional associations under the condition that part of it would be used to establish a library and the remainder expended in research work and propaganda.

2. The sum of 255,000 francs was declared as a premium for the production of peat. Peat producers were allowed to draw upon the State for the sum of one franc per cubic meter of native peat excavated, or 7½ francs per ton of peat produced containing 25 per cent of moisture.

3. Approximately 180,000 francs was awarded as a premium for the purchase of peat producing equipment. Operators were allotted 50 per cent of the price of the material bought.

4. The sum of 50,000 francs was likewise set aside as a premium on apprenticeship, which in a small way reimbursed operators for labor costs.

It is understood that a similar appropriation for 1920 was requested and that a tendency to use it in a like manner has already been manifested.

Peat Industry Important.

Peat is an important industry in France. That country contains a vast quantity of this material and because of the shortage of coal there is a large demand for peat. Much research work has been done and several interesting publications relating to the subject have recently been issued. M. Richemond, of Paris, is the author of a recent excellent treatise on peat that deserves the commendation of the entire industry, and the monthly bulletins of the peat operators contain much data of great value.

Germany.

Peat as a Fuel.

Berlin, August 23.—Peat will probably come into more extensive use as dometic and industrial fuel in Germany as a consequence of the Spa agreement. The municipality of Berlin has started a turf-digging plant on its property at Blankenfelde, where 20 tons of peat are already being produced daily. Mixed with coal, the peat is used to help feeding the boiler fires at municipal power stations.—*Baltimore Star*, Aug. 23, 1920.

Peat Fibre as Cotton Substitute.

The scarcity of raw materials in Germany has compelled manufacturers to find substitutes for the textile industry, and nettles, brooms, and bulrushes have been used instead of flax and wood-pulp fibre in place of cotton. Peat is found in enormous quantities in many parts of Germany, but the amount of

useful fibrous material seldom exceeds 2 to 5 per cent, 10 to 15 per cent being exceptional and only found in a few peat moors. The fibre is only obtained as a by-product in the making of fuel and peat litter, and special machinery has been designed for its extraction. A special bleaching process has been developed by which the brown fibre is turned into a pure white substance resembling cotton. Cloth manufactured from it is extremely porous and suitable for the manufacture of blankets, rugs, underclothing, etc. It has been extensively used in barracks, workhouses, etc., on account of its absorbent qualities in keeping the skin healthy, in this respect resembling wool. It therefore appears probable that it will eventually permanently supplant cotton as a mixture with wool.—*Indian Engineering*, Aug. 14, 1920.

Russia.

Peat Blocks for Fuel.

So serious is the fuel situation in the Baltic States that the Government of Latvia is considering the issuing of wood and peat cards in much the same manner as the other governments of Europe issued, during the war, bread, sugar and milk cards.

As a result of this threatened fuel shortage the Latvian Government has turned its attention to the harvesting of the vast peat deposits which are to be found about Riga, in the country around Kovno, and in other sections. Already the peat market in Riga is one of the interesting spots in the city, while its collection is furnishing employment for scores of men and women.

To prevent profiteerng, the government will place a fixed price upon peat bricks.

In an attempt to educate the people to the use of peat, the stations of the American Red Cross are setting an example by using it for cooking. Red Cross officers are conducting experiments with a combination of peat and other materials in an endeavor to find a fuel which may be used in the manufacturing plants about Riga and thereby reduce the drain on the wood supply of the country.—*New York Financial America*, Sept. 25, 1920.

Sweden.

Use of Peat as Fuel on Swedish Railroads.

Interesting trials to test the possibilities of peat as fuel for locomotives has been in progress for some months on several railways in Sweden. The reports so far show favorable results. One privately owned railroad in southern Sweden, 412 kilometers (256 miles) in length, has found peat so practical for steam purposes that the management believes the road can dispense entirely with coal. The State Railways have likewise been testing peat for steam purposes, with good results, and have on a limited scale adopted it for fuel. For some years the State Railways have been operating a factory for the production of peat powder, which is said to make an excellent fuel.

In Sweden, where there are 10,000,000 acres of peat bogs, with an average depth of 6.6 feet. The substitution of peat for coal would add enormously to the national wealth. Every acre of peat bog yields nearly 1,000 tons of prepared peat.—*Commerce Reports*, Aug. 14, 1920.

CLASSIFICATION AND FORMATION OF PEAT AND RELATED DEPOSITS.

By C. C. Osbon.

Definitions.

The terms "peat" and "muck" are often used indiscriminately to designate either of these materials. This practice is confusing and should be discouraged. Peat is the partly carbonized organic residum produced by an arrest in the decomposition of roots, trunks of trees, twigs, seeds, shrubs, mosses and other vegetation covered or saturated with water. It contains a large proportion of the carbon of the original vegetable matter and the vegetal structure is generally visible without the microscope. It is usually acidic when undrained and the quantity of inorganic matter is much less than that of the organic, pure peats sometimes containing less than 4 per cent of inorganic minerals. Muck is soil containing a high percentage of uncarbonized organic matter. However, the name is commonly applied to drained and oxidized areas of peat under cultivation. Therefore it is difficult to delimit the line of demarcation; peat may grade into muck and muck into peat. If the material will ignite and burn freely when dry, it is usually considered peat.

From an agricultural viewpoint soils, on the basis of their origin, may be conveniently separated into two groups, mineral soils and organic soils.

Mineral soils are those which have been formed by the disintegration and more or less complete decomposition of rocks. Though essentially non-organic in nature they nevertheless contain small amounts of organic matter in various stages of decomposition. This organic material, of both vegetable and animal origin, which rarely exceeds 10 per cent of the soil, may be termed the humus content of mineral soils.

Organic soils are formed in wet and swampy areas, and consist of the remains of plants in a partially decomposed state. When more or less fibrous, brown to black in color, and contain-

ing relatively little ad-mixed mineral matter they are peats. When very thoroughly decomposed, with little or none of the original plant structure distinguishable, and considerable proportions of inorganic matter, largely due to intermingled silt, clay, or sand, they are mucks. A peat rarely has over 30 per cent of ash, and may contain as little as 3 per cent—a muck usually has over 50 per cent ash.

The terms peat, muck and humus have been used by many without much discrimination in their meanings, and consequently many references in the literature will be found which do not agree with the above definitions.

Types of Undrained Land.

The terms "bog," "marsh," and "swamp" are often used interchangeably to indicate the same kind of undrained land surface. It is believed that these terms for the sake of exactness should be used to designate the following types of undrained lands:

Bog. A flat or gently sloping wet area devoid of trees except, in some instances, small scattered patches of tamarack or black spruce, and overgrown principally by sphagnum moss and heath shrubs, or by grasses and sedges. The numerous sphagnum areas of Minnesota, Wisconsin, and the New England States belong to this class.

Marsh. An open shallow basin or relatively flat area covered with water, devoid of trees and overgrown by grasses, sedges, cattails, bulrushes or reeds. The chief difference between bogs and marshes lies in the character of the living vegetation and the quantity of surface water. Marshes often adjoin lakes, rivers and seacoasts, and may contain either fresh or salt water. The Revere Marsh, near Boston, Mass., is a typical salt-marsh, and the marshes adjoining the Charles and Neponset rivers in Massachusetts are good examples of the fresh-water type.

Swamp. A low, flat area covered or saturated with water and overgrown by trees, with or without an undergrowth of shrubs. The surface may be overgrown by a thick mat of vegetation, consisting of small plants, a condition found in many of

Filled-basin peat deposit in which the old shore line is visible.

Built up peat deposit found on a relatively flat surface.

the swamps of New England, or as in some parts of Dismal Swamp, Va., it may be covered with water and comparatively free from small plant growth. Swamps are sometimes named from the trees that predominate in them, as spruce swamp, cedar swamp, gum swamp, cypress swamp, etc. In swamps containing standing water the contribution of sphagnum moss and heath shrubs to the debris from which peat forms is small.

Kinds of Deposits.

Topographic Types.

Classified on the basis of topography there are three general types of peat deposits—the filled basin, in which the peat accumulates in marshes, ponds and lakes; the built-up deposit and its corollary, the climbing bog, in which the peat forms on relatively flat or gently sloping, moist areas not covered with water; and the composite area consisting of built-up peat underlain by peat of filled-basin origin. Plate I illustrates the first two types. Although deposits of all three kinds are found throughout the peat regions, the filled-basin type predominates. Built-up peat forms on areas where the drainage is so greatly interrupted that the soil becomes permanently saturated with moisture. As shown by deep test borings, large areas now covered with built-up peat are underlain by fine-grained peat composed of the remains of aquatic plants, indicating that the built-up stage was preceded by a long period of subaqueous peat formation. The most extensive deposits of lake and built-up peat are in the Great Lakes and New England States, and of marsh peat, in the Atlantic Coast States. Important climbing bogs are found in Maine, and to some extent in the other New England States.

Floral Types.

Classified on the basis of dominant plant growth the eight common types of peat areas are as follows: (1) Pond weed basins, (2) grass-sedge mashes, (3) sphagnum-heath bogs, (4) cedar swamps, (5) spruce swamps, (6) tamarack swamps, (7) gum swamps, and (8) cypress swamps.

Peat-forming Floras.

Filled-Basins.

Beginning at the center of basins filled with water and proceeding shoreward, the usual sequence of vegetation, depending to a large extent upon the depth of the water, is algae and stoneworts, pondweeds, waterlilies, bulrushes, and amphibious sedges. (See Pl. II.) Sphagnum and heath shrubs sometimes grow on the marginal zones and are abundant on the quaking bogs of the northern States. In the northern peat region a growth of tamarack and spruce is often found near the water and in the Atlantic coastal area a zone of gum and cypress, but these trees are not important contributors to filled-basin peat. Adjoining zones of vegetation usually overlap and some plant zones may be absent. Since the quantity of surface and underground water and the acidity or alkalinity of the latter largely determine the flora of a region, and since the gradual accumulation of peat lessens the depth of the water in a peat-forming basin, the vegetal sequence mentioned gives a fairly reliable index to the general dominant plant associations that successively enter into the development of a filled-basin peat deposit.

The following stages of plant growth usually predominate in the order given in peat-forming basins that contain alkaline waters:

(1) Stonewort-water-weed association (*Chara-Philotria Associes*).

(2) Pondweed waterlily association (*Potamogeton-Nymphaea Associes*).

(3) Rush-wild-rice association (*Scirpus-Zizania Associes*).

(4) Meadow association (*Carex Associes*).

Some filled-basin peat deposits, however, because of the influence of fire, drought, and drainage conditions, were not formed by the successive growth and decay of all these plant associations. Changes in the surface water from alkaline to acid also affect the composition of the floras. Fine-grained algal peat is usually found at the bottom of filled-basin deposits, indicating that they had at least a normal origin. This is generally overlain by strata of weed, sedge, and grass peat. Algal peat is usually

Peat-forming pond showing successive zones of (1) pondweed-water lily, (2) sedge, (3) shrub, and (4) forest tree growth.

Built-up bog showing zones of (1) moss, (2) shrub, and (3) forest tree growth.

absent in shallow filled-basin deposits, showing that the second plant association took root in the shallow water soon after the basin was formed and prevented the dominance of algæ and other cryptogamic plants. The mass of peat in some filled-basin deposits consists of fibrous material produced chiefly by the decomposition of sedges and grasses, indicating that the meadow stage predominated for a long time. If a filled-basin peat deposit is destroyed by fire the first stage in the usual succession of plant growth is often resumed after the basin is again filled with water, but if subjected to drainage or drought the earlier stage in the succession of vegetation may, if said conditions prevail, be replaced by bog-heath plants.

Built-up Bogs.

Since built-up peat accumulates on relatively level or gently sloping surfaces the plant associations that successively predominate in peat-forming basins do not materially enter into its formation. As shown by Plate II, the stages of plant growth that contribute to built-up peat are as follows:

(1) Bog-heath association (*Andromeda-Ledum Associes*),
(2) Tamarack-spruce association (*Larix-Ledum Associes*) in the northern region, or
(3) Gum-cypress association (*Nyssa-Taxodium Associes*) in parts of the Atlantic Coastal region.

When built-up deposits are consumed by fire the process of peat formation again begins with the bog-heath stage, unless the area surrounding it is overgrown with trees, in which case it is sometimes resumed with the more advanced stage. The permanent flooding of a built-up bog would convert it into a marsh, and if drained to the depth of a few feet the formation of peat in built-up bogs is usually stopped.

As built-up deposits are largely formed by heath shrubs and mosses the peat usually consists of the remains of only a few plant forms and is therefore relatively homogeneous. Often the peat consists almost entirely of partly decayed sphagnum, especially in the coniferous forest region. Some built-up deposits are overgrown by plants of the same kind that formed the mass of

the peat in them, indicating uniform climatic and topographic conditions for a long time. In many cases, however, the floral development is more advanced and heath shrubs and trees predominate. Many extensive built-up bogs in the coniferous forest areas of the Northern States are in the heath or tree stage.

Composite Areas.

Since composite peat areas consist of filled-basin peat overlain by peat of built-up origin they can not be distinguished from built-up deposits by surface criteria. Their history can only be ascertained by numerous test borings and by a careful study of the topography and of the plant remains. All of the normal stages of plant development often enter into the formation of composite peat and the deposits therefore frequently contain successive strata of algal, rush, grass, sedge, sphagnum, shrub, and tree peat.

Processes of Formation.

Filled-Basins.

Fresh-water Peat.—Most of the peat deposits of this country were formed by the accumulation of plant debris in ponds, fresh-water marshes and lakes, and are called filled-basin deposits. (See Pl. I.) The numerous peat-forming lakes and ponds in all developmental stages found in many parts of the Great Lakes and New England States afford ample evidence of the processes by which the older deposits formed. Test borings usually show that fine-grained peat produced by the decomposition of algæ and other cryptogamic plants, the first to grow in deep water, constitutes the bottom layer of the deep deposits. Coincident with the formation of algal peat in the deep water, pondweeds, waterlilies, sedges, and other plants that take root in shallow water, established themselves on the margins of the basins. Thus the basins were gradually filled with plant debris from the bottom and from the shores. The formation of algal peat is relatively slow, but after the water becomes shallow enough for the growth of pondweeds and sedges in all parts of the basin, the peat accumulates rapidly and soon fills the depression. When

and where the surface of the deposit is raised to the general level of the surrounding country, herbs, sphagnum, and heath shrubs appear and, if moisture is abundant, the filled-basin process will be followed by the formation of built-up peat.

Salt-marsh Peat.—Salt-marsh peat, though formed in practically the same manner as fresh-water peat, differs somewhat in character. Few seed plants tolerate salt water and the number of plant varieties found in salt marshes is therefore rather small. The most common types are salt-marsh grasses, rushes and sedges. The entire vegetation of some of the New England salt marshes consists of one dominant and two or three subordinate species.

In some of the coastal marshes of New England, salt-marsh peat is underlain by peat of fresh-water origin, indicating the subsidence of that portion of the Atlantic Coast. Bastin and Davis[1] in discussing the origin of certain peat deposits on the coast of Maine said in substance:

> It is alleged by some persons that these overlying strata of salt water peat were formed in bays or inlets that had been cut off from the ocean by barrier beaches, and to which salt water was subsequently admitted by wave or current action. This explanation, however, is not satisfactory, because the salt water peat which was formed from the remains of plants similar to those now growing in these marshes, plants that can not exist even a few inches above their present level, is three or more feet thick in many places. It seems, therefore, improbable that the salt-marshes in which this material accumulated were made by the action of waves or currents. A more plausible explanation of the character of these deposits presupposes the gradual subsidence of a coast containing scattered fresh water marshes in which peat was forming. As the sinking of the coast continued these marshes were filled with salt water and peat formed from the decay of salt water plants was deposited upon the fresh water peat. If this theory is correct the thickness of the salt water peat indicates that the coast has been sinking at the rate of about a foot a century. As the fresh water deposits are both underlain and overlain by salt water peat in some places it seems that a slight uplift of the coast preceded the present period of subsidence.

[1] Bastin, E. S., and Davis, C. A., The Peat Deposits of Maine, U. S. Geol. Survey Bull. 376, pp. 20–21, 1909.

Built-up Bogs.

Peat deposits formed by the accumulation of plant matter on relatively level or gently sloping surfaces are called built-up bogs. Plate I illustrates a typical built-up bog. Mosses, grasses, herbs, and heath shrubs, contribute the dead vegetation, and the water, though it may never rise above the surface, is progressively elevated as the peat collects. Surface conditions are little changed from year to year, and hence built-up bogs are relatively homogeneous in structure.

Composite Areas.

When a basin deposit is filled with peat to the level of the surrounding country it is mature and if the moisture is sufficient the built-up process begins. Mosses, herbs and heath shrubs displace the pondweeds, waterlilies, sedges, etc., and thenceforth the deposit develops the same as if it had originated on a relatively level land surface not covered with peat. The result is a composite peat deposit. The peat may accumulate to a thickness of many feet above the former water level in the basin. Composite areas are recognized by a marked change in the structure of the peat where the pondweeds, waterlilies, and sedges were displaced by bog plants.

EXPERIMENTS WITH MUCK SOILS IN GROWING GREENHOUSE CROPS.

By H. C. Thompson,

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Introduction.

In order to study the different types of muck soils and to determine their value in growing greenhouse crops experiments were begun in the fall of 1912. The work was done in cooperation with the American Peat Society. Soils from three different tracts, representing different types of muck, were used. These tracts are located as follows:

1. Northern New Jersey near Great Meadows.
2. Near Mentha, Michigan.
3. Near South Bend, Indiana, in the Kankakee Marsh.

The New Jersey muck prior to its use in these experiments had been under cultivation for at least 25 or 30 years and during a large part of this time had been producing celery, lettuce, and onions. This soil was well decomposed and in good physical condition. It is quite similar to the muck soils found in large areas in the north, especially in New York State.

The Michigan muck was taken from a field which had grown mint and sugar beets for a few years. This type is representative of large areas in Michigan and neighboring states. The soil used was not quite as thoroughly decomposed as the New Jersey soil but would be considered a good agricultural muck.

The Indiana soil used in the experiments was taken from a tract which had been under cultivation for four or five years, but had produced nothing but corn. It was not quite as well decomposed as either the Michigan or New Jersey soils and had not been fertilized, except with very light applications of potash (100 pounds of nitrate per acre) for corn.

The soils used in these experiments were taken from the surface of fields which had produced crops during the season the samples were secured. Two car loads of New Jersey soil and one car load each of Indiana and Michigan soil were secured. With the exception of one car load of New Jersey soil, secured in the fall of 1912, all of the muck was stored in sheds where there was no chance for leaching. The first car of soil from New Jersey was piled in the open air and there was some loss of potash during the year, as shown by analyses made at the beginning of the second season. The yield during the second season (1912–1913) was not as large as that of the first.

The soils used were not artificially dried or treated in any way. In no case was the soil a commercial product. No fertilizer was used in the mixtures employed in the greenhouses, except where noted, and in these cases the applications were made after the soil had been cropped one season without fertilizer.

The mucks used in the experiments were analyzed for lime, potash, phosphorus, and nitrogen, in order to determine whether there was any correlation between the amounts of different elements present and the crop producing capacity of the soils. The following table shows the results of these analyses:

Analysis of Specimens of Muck Soil.
(Analyzed by Bureau of Soils.)

	CaO (per cent.).	K_2O (per cent.).	P_2O_5 (per cent.).	N (per cent.).
New Jersey muck	5.16	0.16	0.42	1.85
Soil of Plat 5 (1912–13)	0.46	0.82	0.36	0.14
Michigan muck	4.05	0.26	0.27	2.15
Indiana muck	5.05	0.27	0.62	3.85

From these analyses it will be seen that all of the mucks were low in potash, high in lime, and high in nitrogen. The Indiana muck contains a relatively high percentage of all these elements.

Crops Used in the Experiments.

During the first year of the experiment lettuce, cauliflower, and tomatoes were grown. The lettuce was a specially selected strain of Grand Rapids, whose seed was produced in the green-

houses of the U. S. Department of Agriculture at Arlington, Va. The cauliflower was a strain of Snowball, selected and grown as mentioned for lettuce. The tomatoes were a special selection of Comet, also grown in the greenhouse at Arlington. The strains of the three crops were selected because of their uniformly desirable characteristics for greenhouse use.

After the first year of the experimental work carnations and roses were also grown. The varieties of carnations used were White Enchantress and Pink Enchantress. During the first two years (1913–14 and 1914–15) of the work with roses the White Killarney and Pink Killarney varieties were used, and in the last (1916–17) the variety, My Maryland, was grown.

Soil Mixtures Used.

During the first year of the experimental work the following identical mixtures were used for all the vegetable crops:

Plat 1. Pure Muck.
Plat 2. ¾ muck, ⅛ clay, and ⅛ sand.
Plat 3. ½ much, ¼ clay, and ¼ sand.
Plat 4. Check, ½ clay and ½ sand.
Plat 5. Check, ½ clay, ¼ sand, and ¼ manure.
Plat 6. ¼ muck, ½ clay, and ¼ sand.
Plat 7. ⅛ muck, ⅝ clay, and ¼ sand.
Plat 8. ½ muck and ½ clay.

The sand and clay were the same as is employed in the general greenhouse work at the Arlington experimental farm, but could not be considered ideal for forcing. The manure in plot 5, which was taken from horse barns, was well rotted and was composted with the sand and clay about a year before it was used. The materials were apportioned by volume.

After the first year plat 5 in all of the series contained 3 parts of clay, 2 parts of manure and 1 part of sand. In the cultivation of tomatoes after the first year the sand was omitted from all mixtures consisting of one-half or more of muck. This changed plats 2, 3 and 8. Plat 8 contained a mixture of one-half muck, three-eighths clay, and one-eighth manure. The percentage of

muck in all plats remained the same for the vegetables throughout the experiment.

For the growth of carnations and roses the mixtures were as follows:

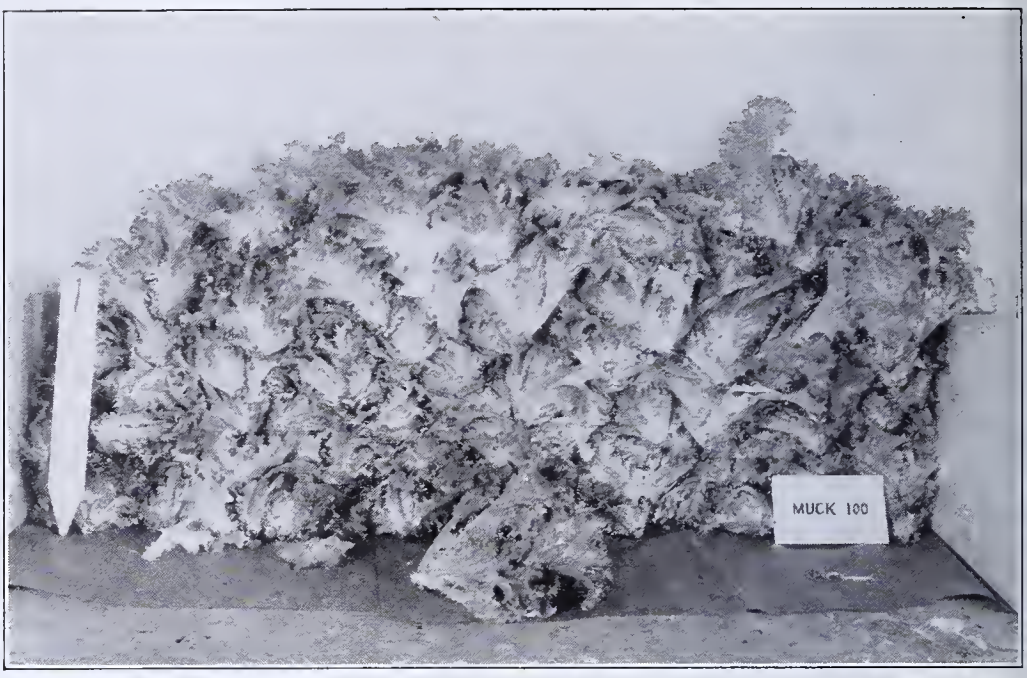
Plat 1. Pure muck.
Plat 2. ¾ muck and ¼ clay.
Plat 3. ½ muck and ½ clay.
Plat 4. Check (clay).
Plat 5. 3 parts clay, 2 parts manure and 1 part sand.
Plat 6. ¼ muck and ¾ clay.
Plat 7. ⅛ muck and ⅞ clay.

No sand was added to any of the mixtures used for the cultivation of carnations and roses. It was thought that the muck would make the mixtures light enough for these crops, which were in the beds for a long period, including the summer months.

Lettuce.

The lettuce seed was sown in flats and when the seedlings reached sufficient size they were transplanted to other flats and spaced two by two inches. When the plants became crowded in these flats they were transplanted in the benches and there they grew to maturity. Raised benches divided into eight plats, each 5 feet 3 inches long and 3 feet 6 inches wide were used. Thirty-five plants were placed in each plat and each series was run in duplicate or triplicate. Some lettuce was grown on benches divided into 8 plats 5 by 7 feet in size.

In harvesting the lettuce the plants were cut off at the surface of the ground and the whole mass weighed immediately. The weights given in the following table are averages for the number of crops grown in the experiments. The New Jersey soil was used three years and produced six crops of lettuce. The Michigan soil was used two years and produced four crops of lettuce. As the Indiana soil produced only two crops and one of these was neglected toward the end of the season the figures are not given. It should be borne in mind that the soil was changed each year. The results shown are based upon two crops of lettuce each year from soil that was replaced annually.



Crop of lettuce grown on plat 1 of the New Jersey muck series, 1913–14.

Crop of lettuce grown on plat 1 of the Michigan muck series, 1913–14.

Plate I illustrates the lettuce taken from the largest yields obtained from the muck soils.

AVERAGE YIELD OF LETTUCE FROM NEW JERSEY AND MICHIGAN MUCK AND OTHER SOILS.

	New Jersey (Pounds).	Michigan (Pounds).
Plat 1	13.80	11.00
Plat 2	12.60	10.87
Plat 3	11.60	10.25
Check plat 4	2.10	5.62
Check plat 5	10.60	13.12
Plat 6	9.70	9.75
Plat 7	6.80	8.87
Plat 8	12.90	10.37

An examination of this table shows that check plats 4 and 5 in the Michigan series produced larger yields than the same plats in the New Jersey series. Why this occurred cannot be easily explained. It is true that the clay used in the later years was of better quality than that used in the first two years, but this does not fully explain the difference. The largest yield of lettuce in the New Jersey series was on plat 1, containing pure muck, followed by plats 8, 2, and 3 in the order given. In the Michigan series the highest yield was on check plat 5 (not muck), followed by plats 1, 2, 8 and 3 in the order given. The plats containing one-half or more of muck gave a larger yield in the New Jersey series than in the Michigan series, though the reverse is true in the plats containing no muck. This would substantiate the previous statement regarding the clay used in the later years. The loss of potash from the New Jersey soil used the second year (due to leaching caused by exposure) undoubtedly reduced the yield, as the crops grown that season were smaller than those grown during the first and third seasons. The weather, especially the difference in sunlight in different seasons, might also have been a factor.

CAULIFLOWER.

The seed was sown in flats and when the plants reached sufficient size they were transplanted to stand two by two inches. After they became crowded in the second flat the plants were set

into the permanent bed. The plats used for cauliflower were 5 by 7 feet and 24 plants were planted in each plat. The first crop each season was planted in October in the permanent bed and the second crop followed as soon as the first was removed, which was usually early in January.

When the cauliflower was ready to harvest the plants were cut off at the surface of the ground and the whole mass was weighed. Then the head was cut off and the leaves trimmed back nearly to the surface of the head, as is the usual custom in preparing the product for market. After trimming, the heads were separated into two grades, marketable and non-marketable.

The New Jersey soil was used for three seasons and produced five marketable crops; the Michigan soil was used two seasons and produced three marketable crops; and the Indiana soil was used for only one season and produced only one good crop. The second crop on the Indiana soil became diseased and produced very few marketable heads. Therefore only the first crop is considered in the summary. Plate II illustrates the growth of cauliflower on New Jersey muck and shows the average yield for four crops.

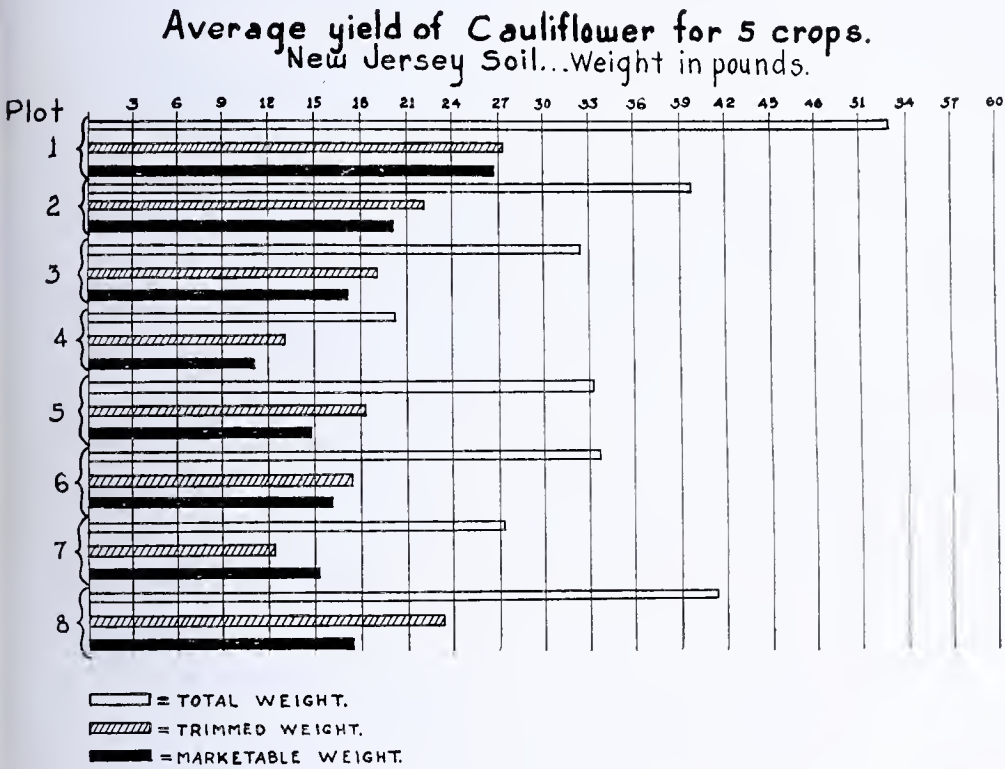
The following table shows the average yield per crop of the five crops grown in the New Jersey series from 1912 to 1915:

Average yield per crop of cauliflower from New Jersey muck and other soils.

Plat No.	Number of plants.	Weight, gross (pounds).	Weight, trimmed (pounds).	Marketable.		Non-marketable.	
				Number of plants.	Weight (pounds).	Number of plants.	Weight (pounds).
1	23.8	52.15	27.40	18.8	23.85	5.0	4.10
2	23.8	40.80	22.80	17.8	19.65	6.0	3.20
3	23.2	35.20	19.60	16.4	17.10	6.8	2.50
Check 4	23.6	20.15	13.70	14.0	11.00	11.0	2.70
" 5	24.0	33.60	18.50	14.8	14.35	9.2	4.15
6	23.8	33.85	17.80	16.8	14.85	7.0	2.75
7	23.6	27.40	17.25	15.4	13.05	8.2	4.20
8	23.2	41.80	23.70	17.6	21.15	5.6	2.55

An examination of this table shows that the highest yield of trimmed heads was on plat 1 containing pure muck, followed by plats 8, 2, 3, check plat 5, plats 6, 7 and check plat 4, in the order

Cauliflower growing in the New Jersey muck series of 1913–14.



Average yield of crops of cauliflower grown in New Jersey muck and other series.

given. In this experiment the plat containing one fourth muck produced nearly as much cauliflower as the plat containing one fourth and one third manure, one fourth in 1912–13 and one third in the other years.

The following table gives the results of growing cauliflower on Michigan muck. The figures are the averages for three crops, two grown in 1914 and 1915 and one in 1915 and 1916:

AVERAGE YIELD PER CROP OF CAULIFLOWER ON MICHIGAN MUCK AND OTHER SOILS.

Plat No.	Average number of plants.	Total weight (pounds).	Weight, trimmed (pounds).	Marketable.		Non-marketable.	
				Number of plants.	Weight (pounds).	Number of plants.	Weight (pounds).
1	24.00	26.92	14.91	15.33	11.75	8.66	3.58
2	24.00	30.17	16.16	15.66	13.21	8.33	2.96
3	23.66	27.08	15.59	16.66	13.25	7.00	2.33
Check 4	24.00	15.17	8.25	7.00	4.12	17.00	4.12
Check 5	23.33	39.79	21.91	19.66	20.50	3.66	1.41
6	24.00	24.12	14.25	17.66	12.20	6.33	2.04
7	24.00	22.50	13.33	15.66	10.61	8.33	2.71
8	23.66	31.75	17.96	19.66	16.58	4.00	1.39

The highest yield of cauliflower in the Michigan series was on check plat 5 (not muck), followed by plats 8, 2, 3, 1, 6, 7 and check plot 4 in the order given.

The following table shows the yield of one crop of cauliflower grown in the Indiana muck series in 1915 and 1916.

YIELD OF ONE CROP OF CAULIFLOWER IN INDIANA MUCK AND OTHER SOILS.

Plat No.	Average number of plants.	Total weight (pounds).	Weight, trimmed (pounds).	Marketable.		Non-marketable.	
				Number of plants.	Weight (pounds).	Number of plants.	Weight (pounds).
1	22	48.0	25.12	22	25.12	0	0
2	24	40.5	21.12	24	21.12	0	0
3	24	34.0	18.00	21	17.50	3	0.50
Check 4	24	6.0	2.50	0	0	24	2.50
" 5	24	50.0	26.50	24	26.50	0	0
6	24	25.5	13.00	18	11.25	6	1.75
7	24	17.0	9.25	0	0	24	9.25
8	24	38.5	20.50	22	20.25	2	0.25

The second crop on the Indiana series, planted on January 25 and harvested on April 17, 1916, was very poor even on check plat 5 (not muck), which contained a good greenhouse soil. Why

the yield was so small on all the plats cannot be explained. The record of the yield is given, however, in the next table in order to make a comparison with the crop grown the following year on the same soil.

YIELD OF SECOND CROP OF CAULIFLOWER IN INDIANA SERIES, 1915–16.

Plat No.	Average number of plants.	Total weight (pounds).	Weight trimmed (pounds).	Marketable.		Non-marketable.	
				Number of plants.	Weight (pounds).	Number of plants.	Weight (pounds).
1	24	12.50	4.25	1	0.50	23	3.75
2	24	13.50	5.50	6	2.50	18	3
3	24	9.75	3.50	3	1	21	2.50
Check 4	24	4.75	2	1	0.50	23	1.50
Check 5	24	18.50	10.75	12	8	12	2.75
6	24	5.50	2.75	3	0.75	21	2
7	24	6	3.25	2	0.75	22	2.25
8	24	13	7.50	10	5.50	14	2

In order to determine whether the plant food in the soil became exhausted in growing one good crop and one poor one the soil was kept for the following season. After the crop was harvested on April 17, 1916, the soil was allowed to dry and remain in the benches throughout the summer without any crop. On August 28, 1916, cauliflower plants were set in the beds. On December 6, 1916, the crop was harvested, the results being given in the following table:

YIELD OF ONE CROP OF CAULIFLOWER IN INDIANA MUCK AND OTHER SOILS WHICH HAD BEEN CROPPED THE PRECEDING SEASON.

Plat No.	Average number of plants.	Total weight (pounds).	Weight, trimmed (pounds).	Marketable.		Non-marketable.	
				Number of plants.	Weight (pounds).	Number of plants.	Weight (pounds).
1	24	48.25	22.50	20	20	4	2.50
2	24	45.75	21.75	18	19.25	6	2.50
3	24	40	20	19	18	5	2
Check 4	24	19.25	9	11	5.25	13	3.75
Check 5	24	42.75	22.50	18	20.25	6	2.25
6	24	33.25	15.25	15	12.50	9	2.75
7	24	28.25	14.50	15	11	9	3.50
8	24	46	23.75	23	23.50	1	0.25

By comparing this table with that on page 51 it will be seen that the yields of the first and third crops were not very different.

The foliage on plat 1 showed quite serious burning. Plat 2 showed some burning, but none of the other plats showed any injury. It was thought that the injury was due to excess of available nitrogen, which probably was set free during the summer. The appearance of the injured leaves was very much the same as can be seen when too much nitrate of soda is applied to a crop.

Results of Fertilizer Applications on Muck That Has Become Somewhat Exhausted.

In order to determine whether commercial fertilizers could be used to advantage on soils that had become somewhat exhausted by previous cropping in the greenhouse, experiments were conducted with cauliflower on both the New Jersey and Michigan series. The mixtures used in 1913 and 1914 in the New Jersey series produced two crops. Then the soil was allowed to dry and was left in this condition until the latter part of October, 1914, when it was worked up and watered thoroughly. On October 27 plants were set out for a third crop of cauliflower. No fertilizer was used for this crop. The yields are recorded in the following table:

Yield of cauliflower on New Jersey muck and other soils which had been cropped the previous year.

Plat No.	Average number of plants.	Total weight (pounds).	Weight, trimmed (pounds).	Marketable.		Non-marketable.	
				Number of plants.	Weight (pounds).	Number of plants.	Weight (pounds).
1	24	29.25	17.25	18	14.50	6	2.75
2	24	27.25	16	18	13.25	6	2.75
3	23	25.25	15.75	20	14.50	3	1.25
Check 4	23	8.25	5.25	0	0	23	5.25
Check 5	24	24.50	14.25	16	11.25	8	3
6	24	18.75	11.50	14	8.75	8	2.75
7	24	14.25	8	7	4	17	4
8	24	19.25	10.25	11	6.25	13	4

The third crop was fairly good considering the fact that two crops had already been produced on the soil, which was only six inches deep in the benches. The first three plats, containing pure

muck, three fourths and one half muck, respectively, produced higher yields than did check plat 5.

After producing the third crop the soil was worked up and fertilized with 1½ pounds per plat of a 4–8–10 fertilizer. This mixture contained nitrate of soda, dried blood, bone meal and muriate of potash. The fertilizer was applied on the surface and mixed thoroughly with the soil before the plants were set. The yields for this fourth crop is given in the following table:

YIELD OF CAULIFLOWER IN NEW JERSEY FERTILIZED SERIES.

Plat No.	Average number of plants.	Total weight (pounds).	Weight, trimmed (pounds).
1	24	54	32.75
2	24	57.50	33.75
3	24	52.50	28.50
Check 4	24	42.75	25.25
Check 5	24	49.75	27
6	24	50.25	32.25
7	24	48	29.25
8	24	56.75	35

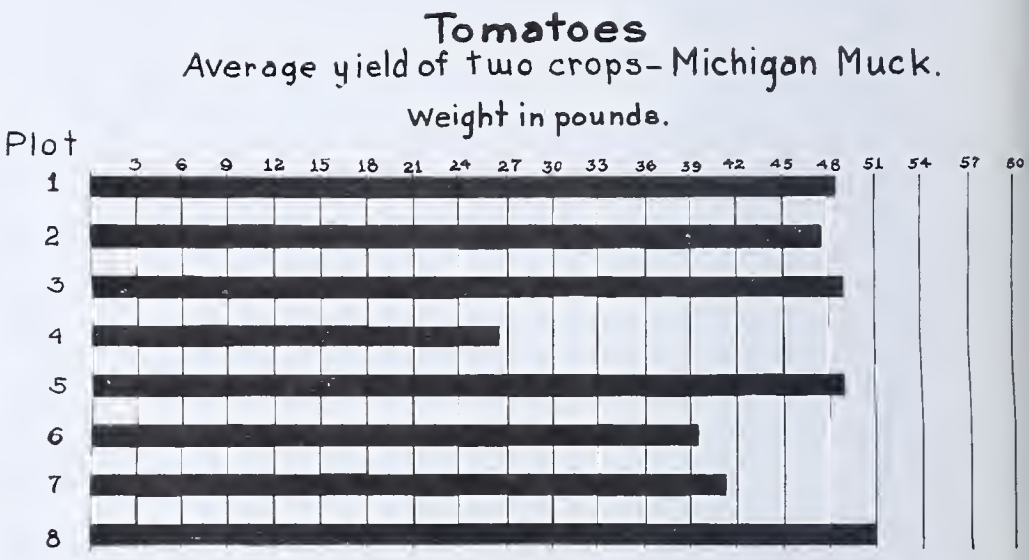
All the heads were marketable. The figures given in this table show that available plant food was the principal limiting factor. All plats produced a good yield when supplied with a complete fertilizer. The largest yield was produced on plat 8, containing one half muck and one half clay.

The results of fertilizers on the Michigan muck series were very similar to the results on the New Jersey series. The soil used in 1913 and 1914 was kept for use the following season and was handled in exactly the same way as the New Jersey soil. The results for the third crop on the same soil is given in the following table.

YIELD OF CAULIFLOWER IN MICHIGAN MUCK AND OTHER SOILS WHICH HAD BEEN CROPPED THE PREVIOUS YEAR.

Plat No.	Average number of plants.	Total weight (pounds).	Weight trimmed (pounds).	Marketable.		Non-marketable.	
				Number of plants.	Weight (pounds).	Number of plants.	Weight (pounds).
1	23	18.75	11.75	11	7.25	12	4.25
2	24	14.50	9.25	10	5.50	14	3.75
3	24	13.25	8.50	12	5	12	3.25
Check 4	24	5.50	3.75	0	0	24	3.75
" 5	23	22.25	14.50	16	12.25	7	2.25
6	24	11.50	7.25	5	2.75	19	4.50
7	24	12	8.50	9	4.25	15	4
8	24	19.25	13.25	17	11	7	2.25

Crop of tomatoes grown in plat 8 in the New Jersey muck series 1912–13.



Average yield of two crops of tomatoes grown in Michigan muck series, 1913–14.

After the third crop was removed on January 19, 1915, the soil was worked and fertilized in the same way as the New Jersey soil series. The yields for the fourth crop are given in the following table:

YIELD OF CAULIFLOWER IN MICHIGAN SERIES AFTER BEING FERTILIZED FOR FOURTH CROP.

Plat No.	Average number of plants.	Total weight (pounds).	Weight trimmed (pounds).	Marketable.		Non-marketable.	
				Number of plants.	Weight (pounds).	Number of plants.	Weight (pounds).
1	24	47.75	26	24	26	0	0
2	24	39	18.50	24	18.50	0	0
3	24	36.75	18	23	17.75	1	0.25
Check 4	24	27	12.75	19	11	5	1.75
" 5	24	37.75	20	24	20	0	0
6	24	39.75	21.25	22	21	1	0.25
7	24	33.25	20.50	21	20	2	0.50
8	24	42.75	25	24	25	0	0

An examination of this table shows that all of the plats produced fair yields, the largest being on plat 1, followed by plats 8, 6, 7, check plat 5, and plats 2, 3 and check plat 4 in the order given.

TOMATOES.

Two crops of tomatoes were grown in the New Jersey series and one crop in the Michigan series. This plant was not used in the Indiana series. The plats used for tomatoes were the same size as those used for cauliflower (5 feet 3 inches by 7 feet). In the first year, 1912–13, the soil mixtures were also the same as used for cauliflower, but in the second year, 1913–14, the sand was left out of the mixtures in plats 1, 2 and 3. Plat 8 consisted of one half muck, three eighths clay and one eighth manure. The percentage of muck in the mixtures was the same throughout the experiment. The Comet, a small variety of forcing tomato, was used in this experiment. The plants were grown to good size in pots before being set in the benches. The following table and chart (Pl. III) give the average yield of two crops:

YIELD OF TOMATOES GROWN IN THE NEW JERSEY SERIES, 1912–13, AND IN THE MICHIGAN SERIES, 1913–14.

Plot No.	Weight of Fruit Harvested (in Pounds). New Jersey.	Michigan.
1	58.25	48.50
2	59.50	47.50
3	59.00	49.00
4	38.50	26.25
5	52.00	49.00
6	50.00	39.50
7	45.13	41.00
8	61.50	51.00

The crop of tomatoes raised in 1913 and 1914 was not as good as the one grown in 1912 and 1913, but this was probably due to a difference in the season and the loss of potash due to leaching. The crop was planted later in the latter experiment than in the former, and this would favor the former because of longer days and more sunlight at the time of fruit setting. It is apparent that the highest yield in the New Jersey series was on plat 8, followed by plats 2, 3, 1, 5, 6, 7 and 4 in the order given, although there was slight difference in plats 1, 2 and 3. The highest yield in the Michigan series was on plat 8; plats 3 and 5 produced the same amount of fruit and plats 1 and 2 were not far behind. The yields in the two series are not directly comparable, as the Michigan soil produced practically as much as the New Jersey soil in 1913 and 1914.

There was very little difference in the time of ripening on the different soil mixtures, although the high yielding plats produced more during the first two or three pickings than the low-yielding plats. The heaviest foliage was on the plats containing pure muck and decreased as the percentage of muck decreased.

Muck soil is not considered a desirable soil for tomatoes, but the results obtained in the experiments recorded above seem to indicate that a mixture of one half muck and one half clay is a good combination.

ROSES.

Two varieties of roses, the Pink Killarney and White Killarney, were grown in the New Jersey series in 1913–14, and one variety, My Maryland, was grown in the Michigan and Indiana series.

The soil mixtures for all of the experiments with roses were as follows:

Plat 1. Pure muck.
Plat 2. ¾ muck and ¼ clay.
Plat 3. ½ muck and ½ clay.
Plat 4. Check (clay).
Plat 5. 3 parts clay, 2 parts manure, and 1 part sand.
Plat 6. ¼ muck and ¾ clay.
Plat 7. ⅛ muck and ⅞ clay.

The roses grown in the New Jersey series were propagated from greenhouse stock grown at Arlington Farm. The plants were pot grown and set in the greenhouse benches in June. They were grown on raised benches and given the usual care. Records were tabulated by months, beginning in October, 1913, and ending in April, 1914. At each cutting the flowers were separated into two grades designated firsts and seconds. Those classed as firsts were perfect blooms with stems over 6 inches long and those classed as seconds were good blooms with stems less than 6 inches long.

The yield of roses on the New Jersey soil is given in the following table:

Roses grown in New Jersey muck, 1913–14.

Plat No.	Number of blooms.	Number of firsts.	Number of seconds.
1	674	157	517
2	631	282	349
3	814	707	107
4	252	206	46
5	692	571	121
6	690	565	125
7	593	468	125

The best and largest blooms, the highest per cent. of first grade, and the largest number were produced on plat 3, containing 50 per cent. muck and 50 per cent. clay. The foliage was heavier and of a darker green color on all plats containing 50 per cent. or more muck than on plats 4 and 5. The plants on plats 1 and 2 were very vigorous and had to be pruned back a number of times during the season, but the buds were not as

good as on the other plats. Plat 6, containing one fourth muck, produced about the same number of blooms as plat 5 which had one third manure. The luxuriance of the foliage and the small percentage of good blooms on the plants grown on plats 1 and 2 indicated an excess of available nitrogen and probably a deficiency of potash and phosphoric acid. In order to determine whether the addition of commercial fertilizer would improve the quality of the blooms the following fertilizer treatments were applied to the crop grown in 1915 and 1916. On plats 1, 2, 3 and 6 one pound per plat of a mixture consisting of approximately 3 parts of bone-meal and two parts muriate of potash, and on plats 4, 5 and 7, one and one-half pounds per plat consisting of approximately 3 per cent. of nitrogen, 8 per cent. of phosphoric acid and 10 per cent. of potash, were used. The nitrogen came from nitrate of soda and dried blood, the phosphoric acid from bone-meal, and the potash from muriate. Two applications were made to all of the plats, the first one before the plants were set out and the second one during the winter.

The yield of roses in this experiment in 1915 and 1916 is given in the following table. The soil mixtures were the same as those used in 1913 and 1914.

Roses grown in fertilized muck from New Jersey, 1915–16.

Plat No.	Total number of blooms.	Number of firsts.	Number of seconds
1	807	670	137
2	995	836	159
3	1007	867	140
4	769	666	103
5	975	831	144
6	1087	918	169
7	1088	894	194

A comparison of this table with the next preceding one shows that the number of blooms was greater on every plat in 1915 and 1916 than on the corresponding plats in 1913 and 1914. The percentage of first class blooms was also greater when the fertilizer was applied. This was especially noticeable on plats 1 and 2. The mixtures containing one eighth and one fourth muck, when treated with commercial fertilizer, gave excellent results.

The yields of plats 6 and 7 were larger than the yield of plat 5 which contained one third manure and was treated with the same fertilizer mixture as plat 7.

The yield of roses on the Michigan muck series is given in the following table. The variety grown in this series is different from that grown in the New Jersey series. The plants were bought from a commercial plant grower and were of good size for setting in the benches when received.

Roses grown in the Michigan muck series, 1916–17.

Plat No.	Total number blooms.	Number of firsts.	Number of seconds.
1	779	610	169
2	650	524	126
3	737	565	172
4	568	397	171
5	825	660	165
6	775	592	183
7	688	536	152

The yield of roses was greater on all plats, except plat 3, in the Michigan series than in the New Jersey series, but this has no special significance as different varieties were used. It will be noticed that plat 5 gave the highest yield of blooms and the greatest number of firsts. The percentage of good blooms was fairly high on all the plats. The foliage on plat 1 of the Michigan muck was not as heavy as on the same plat of New Jersey muck, due probably to slower availability of the nitrogen in the former. This might also account for a larger percentage of firsts from the Michigan muck in plat 1.

The yield of roses in the Indiana series is given in the following table. The crop was grown in the same season as the crop on the Michigan muck and the yields on these two soils are therefore comparable.

Roses grown on Indiana muck, 1916–17.

Plat No.	Total number of blooms.	Number of firsts.	Number of seconds.
1	888	637	251
2	724	544	180
3	794	566	228
4	622	446	176
5	854	642	212
6	745	527	218
7	760	536	224

The largest number of blooms was produced on plat 1 followed by plats 5 and 3. The percentage of firsts, however, was higher on plat 5 than plat 1.

Carnations.

The carnations grown in the New Jersey muck series were propagated from greenhouse stock and were grown entirely indoors. They were planted in permanent beds early in the summer and records were kept from the first of October to the last of March and April. The variety grown was the Pink Enchantress. The soil mixtures were the same as for roses. After the flowers had been picked they were separated into two lots designated good and splits. The yield of blossoms in the New Jersey series is given in the following table:

Yield of carnations in New Jersey series.

Plat No.	Total number blooms.	Number good blooms.	Number of split blooms.
1	824	629	195
2	773	587	186
3	777	638	139
4	610	487	123
5	967	832	135
6	811	665	146
7	748	603	145

Good flowers were produced on all of the plats, but the highest yield was on plat 5, followed by plats 1, 6, 3, 2, 7 and 4 in the order given. The largest flowers and the largest and longest stems were produced on plat 3. The stems were large and long on all the plats containing one fourth or more of muck. Carnations gave poorer results in mixtures containing one half or more of muck, in comparison with check plats 4 and 5, than any other crop used in the experiments.

Carnations were grown in the Michigan and Indiana series in 1916 and 1917 and for some reason the yields were uniformly low on all of the plats. This might have been due to the season to some extent, but probably more to poor stock. In both series the yield on plats 4 and 5 was less than half the yield on the corresponding plats in the New Jersey series, indicating poor grow-

ing season or difference in the stock used. It could not have been due to the soil as the mixtures in plats 4 and 5 were the same as used in growing the lettuce and cauliflower. In these experiments the plants used were secured from a commercial plant grower, and though the plants appeared strong and healthy they did not develop as well as the plants grown in the New Jersey series. The growth was normal throughout the season, but there was a decided lack of blosssoms compared to the homegrown stock. The same variety was grown in the Michigan and Indiana series as in the New Jersey series but the stock was not pure in the former. The results are given in the succeeding table:

YIELD OF CARNATIONS IN MICHIGAN AND INDIANA SERIES.

Plat No.	Michigan.			Indiana.		
	Total number of blooms.	Number of good blooms.	Number of split blooms.	Total number of blooms.	Number of good blooms.	Number of split blooms.
1.....	351	305	46	527	468	59
2.....	396	307	89	429	381	48
3.....	347	266	81	410	356	54
4.....	266	220	46	272	235	37
5.....	394	318	76	443	342	101
6.....	343	252	91	399	322	77
7.....	330	248	82	451	382	69

An examination of this table shows that in the case of the Michigan series the yield on plats 2 and 5 was about the same, though in the Indiana series the highest yield was on plat 1. The highest percentage of good flowers was also on plat 1 in the Indiana series.

CONCLUSIONS.

Throughout the experiments there was considerable inconsistency in the results secured. The yields on the same soil mixtures varied widely. This cannot be fully explained as the work was done by the same men and an effort was made to have uniform conditions. As to heat and moisture, the factors under control, this was accomplished. The amount of sunlight is an important factor in growing greenhouse crops and of course this varied and was not under control. Possibly this factor is the main one responsible for the differences in results secured. How-

ever, it is impossible to interpret some of the results obtained in these experiments when all of the factors are considered. The writer presents the data to show what might be expected in work of this nature so that other workers may eliminate as many of the variable factors as possible. If all of the soils were used at the same time and under the same conditions the seasonal variations would be eliminated. The lettuce, cauliflower and tomato seed used in these experiments were probably the best available for this work. The strains were uniform and true to type and the variations in yields cannot therefore be attributed to the seed stocks. The carnations and roses used in the New Jersey soil series experiment were also pure stocks.

It is believed that the data presented, even with the inconsistencies, show that a good type of muck is a valuable soil for growing greenhouse crops. While the pure muck produced good crops of lettuce, cauliflower, and tomatoes it would not be desirable under most conditions to use more than one half or possibly one fourth muck. Under present methods of growing vegetables in the greenhouse it would probably require an application of two or three inches of muck to the surface soil to take the place of manure. The muck should be supplemented with commercial fertilizer to make up the deficiency in potash and phosphoric acid. Where fertilizer was used in the experiments one fourth muck in the soil mixture gave as good results as one third manure. With roses one eighth muck, supplemented with commercial fertilizer, produced as many blooms as one third manure and commercial fertilizer. The cost of muck might be prohibitive under some conditions, but where it is available at a low price it might be used to advantage, especially by greenhouse men who own muck land. With the continued decrease in horses in our cities, resulting in a shortage of manure, greenhouse men may be forced to find a substitute for manure. Muck, it would seem, is the most logical substitute.

From the data presented, it is evident that a chemical analysis does not give any indication of the crop producing capacity of muck soil. In most cases the soil containing the smallest amount of the three important elements of plant food produced the largest

yield. An analysis shows only the percentage of each element present and does not indicate the amount available to the plant. The stage of decomposition of muck soil has more effect on crop production than the amount of total nitrogen, phosphoric acid and potash present. In fact the more advanced the stage of decomposition the better the soil for crop production. This is doubtless due to the fact that the more thoroughly a soil is decomposed the greater the availability of the plant food. This was shown in the work in the greenhouses, and also in field work on muck soils carried on in conjunction with the experiments recorded in this paper.

THE TREND OF RESEARCH WORK IN THE AGRICULTURAL UTILIZATION OF PEAT LAND.

Although peat land is extensively cultivated in the United States, the success that has attended its utilization may be ascribed in many instances to good fortune rather than to scientific crop adaptation. Failures have been numerous and statements have been made in some instances that peat land is too sour for the growth of crops. Some peats do not contain enough potash and others are deficient in phosphorus, but as a class they constitute one of the most fertile soil types in this country, and if correctly treated and used for the growth of proper crops they will yield large returns.

Most of the failures that have occurred and the allegations of unproductivity are based upon a misconception of the nature of peat and of the relation of the crops to its acidity or alkalinity. In 1913 it was pointed out by Coville[1] that many species of plants required an acidic soil for successful growth. Later in 1914 he mentioned the types of plants that required an alkaline soil.[2] Despite his advice to the contrary crops have been sown indiscriminately on peat land without a determination of its acidity or alkalinity and absolute failure has often resulted.

Most of the undrained peat land in the United States is strongly acidic and therefore can not be successfully used without treatment for the cultivation of crops that require an alkaline soil. Some of the cereals will not tolerate an acid soil, but there are many truck and other crops that grow profusely on acid land. The successful cultivation of the vast peat lands is directly dependent upon the recognition of this fundamental difference between soils and plants and upon the appropriate adaptation of crops.

[1] Coville, F. V., "The Agricultural Utilization of Acid Lands by Means of Acid-Tolerant Crops," Bull. U. S. Dept. Agri., Sept. 1913.

[2] Coville, F. V., "The Formation of Leafmold," Pub. 2289, Smithsonian Institution, 1914.

American agriculture has heretofore consisted chiefly of plants that thrive best upon alkaline or neutral land. Accordingly the acidic peat areas have not been productive when used for the cultivation of these crops without special treatment and these areas have been passed by or subjected to expensive treatment. However, with the rapid increase of our population and the advent of intensive soil cultivation the attention of agriculturists and others is now being directed to these neglected lands. Many of our plants tolerate acidity and there are large opportunities for the use of acid peat lands by means of acid-tolerant crops.

Raw peat soils, though too acidic for ordinary farming, are after they have been drained, cleared, freely aerated, and properly fertilized, especially well adapted to the production of vetch, redtop, millet, buckwheat, oats, corn, rye, the potato, the cranberry, the blueberry, the strawberry, and other acid-tolerant crops. If properly treated with potash salts and with lime they are neutralized or made slightly alkaline and should then yield large quantities of red clover, timothy, blue grass, wheat, rutabagas, and other alkaline or neutral-soil crops. The greatest returns derived from the cultivation of peat, however, have arisen from its use as a truck crop soil. Cabbage, onions, celery, lettuce, spinach, carrots, beets, turnips, and peppermint are the most valuable crops that are grown on treated areas of peat. The acreage values of these crops so far surpass those of the general farm crops that the reclamation of any large areas of peat should be undertaken with the special object of their production.

As so well said by Coville in the publication referred to:

> Soil acidity is not always an objectionable condition that requires an application of lime. Under certain economic conditions a complete system of acid-land agriculture is practicable and desirable. The extent to which our cheap eastern acid (peat) lands can be utilized with small applications of lime, or under some conditions without its use, is a legitimate and important subject for detailed investigation from which may reasonably be expected results of far-reaching economic importance.
>
> Thus far man has devoted himself largely to the utilization of the plants of the leafmold (alkaline or neutral soil plants), which have

gathered up for him the wealth of the earth. Let him now, I say, turn his attention also to the plants of the peat and try whether they will not yield to him in increased measure the luxuriance of foliage and of fruit that they have always yielded without assistance to nature herself.

Methods have recently been devised by which the acidity or alkalinity of soils may be determined by simple color tests in the field.

This, it is believed, shows the trend of research work in the agricultural utilization of peat land, and the beginning of a period of the more extensive cultivation of acid-tolerant crops.

SOIL SURVEYS.

Beaufort County, North Carolina.

By W. B. Cobb and Others,
United States Department of Agriculture.

Muck.

Muck consists of well-decayed vegetable matter mixed with varying though relatively small quantities of mineral matter. It is black or very dark brown in color and has a depth ranging from 30 inches to several feet. Frequently the surface material to a depth of 2 or 3 inches is composed of peat—practically pure vegetable matter which has not reached so advanced a stage of decomposition as the underlying muck, and which still retains something of the original structure of the plants. In cultivated areas this surface layer is absent owing to the fact that in clearing the land for cultivation it is generally burned off. Muck as mapped in Beaufort County is generally underlain by a gray fine sand which passes below into a fine sandy clay of the same color, although in some instances the fine sandy clay is encountered just beneath the muck, while in other places the underlying material is a gray or drab clay. In one or two places the muck is underlain by marl, but at depths of more than 3 feet.

Muck occurs in East Dismal and Pantego Swamps in the northeastern part of the county and in Gum Swamp south of Aurora. It is naturally poorly drained.

The soil is not extensively farmed, but much of it is being drained and about 5 per cent. is now in cultivation. Uncultivated areas are generally heavily forested with hardwood. The most characteristic growth consists of black gum or swamp gum, maple, and cypress. The undergrowth is characteristic of the swamps of the region.

Corn is the only crop extensively grown on muck. This land produces about the same yields and is handled in about the same way as the Hyde loam. It is, however, not quite so strong a soil.

It sells for $20 to $200 an acre, its value depending on location, drainage, state of cultivation, and improvements.

Muck, Shallow Phase.—The shallow phase of muck consists of a black organic layer 10 or 12 inches thick, underlain by gray fine sand. Areas of this description occur in the southern part of Pantego Swamp. They are not so well suited to agriculture as areas of the typical muck. They support a scattered growth of pines, with an undergrowth of bay, briers, and reeds. Moss and ferns are of common occurrence. The phase is valued at about $10 an acre.

Swamp.

Swamp as mapped in Beaufort County consists of strips of alluvial land along streams. These areas are subject to frequent inundation, and are covered with water the greater part of the year. The surface material generally consists of peat or muck or dark-colored sandy loam or loam, and varies in depth from an inch or two to 2 or 3 feet. It is underlain by a grayish fine sand, a mottled yellow and gray clay, or less frequently by a drab clay with some brownish mottlings. In many instances the surface material, which is composed largely of vegetable matter in varying stages of decay, has been modified considerably by material washed down from more elevated areas of various soils. The quantity and texture of this material vary greatly in different areas, being determined largely by the type of the soil from which it has been washed. In Creeping Swamp, along the Pitt County line, the swamp material is a drab clay.

The swamp areas are generally so low that it would be impracticable to drain and cultivate them. Many of them are elevated only a foot or two above sea level. Areas of swamp occur along nearly all the streams in the county. Along the larger streams the areas are more or less discontinuous, and in some places they are broken by areas of tidal marsh.

Swamp is not utilized, except to a small extent for the grazing of cattle. It is valued chiefly for its timber.

Tidal Marsh.

Tidal marsh comprises marshy, grassy areas located between upland soils and tidal streams. It generally consists of a surface

layer of muck or peat, from 6 to 30 inches thick, underlain by a silty loam, generally gray or drab in color and in many places mottled with yellow. This grades into drab or bluish, extremely plastic clay.

Tidal marsh lies principally along the tidal streams in the eastern part of the country, although some areas are mapped in the vicinity of Washington. The surface is at, and drainage is entirely lacking. Normal tides flood the marshes, and may completely cover the tall marsh grass which characteristically makes a heavy growth. Cattle are grazed to some extent on these marshes, but otherwise the areas are not used for agriculture.

Waupaca County, Wisconsin.

By Cornelius Van Dyne and Others,
United States Department of Agriculture.

Peat.

The areas mapped as peat consist of vegetable matter in varying stages of decomposition, with which there has been incorporated a small quantity of mineral matter. Where raw and fibrous, and only slightly decomposed, the peat has a brown color, but where more completely decayed it becomes darker and in places black. It is light in weight as compared with other soils, and naturally loose and spongy. The surface material is often lighter brown than that at a depth of 2 feet or more, especially in the timbered marshes. In some instances the more thoroughly decomposed material occurs at the surface and the raw, fibrous, peaty matter is found at lower depths. This appears to be the case most frequently where the marshes were originally treeless.

The organic material in the peat areas ranges in depth from 18 inches to over 3 feet. Where its depth is less than 18 inches it is mapped separately as a shallow phase. In some instances the peat is known to be over 10 feet deep. The material underlying the peat is variable. Where the surrounding soils are sandy it is usually underlain by sand, and where the upland bordering the

marsh is heavy, the underlying material of the peat is usually heavy also.

Peat is the most extensive soil mapped in the county. It exists in practically all parts of the county, the areas varying in size from a few acres to several square miles. Among the more extensive areas are the one 5½ miles southwest of Clintonville, one 2½ miles east of Manawa, and another immediately northeast of White Lake. East of Embarrass there are several smaller bodies and numerous less important ones are scattered throughout the county. The Gloucester, Kewaunee and Superior soils are in many places separated by areas of peat.

The surface of the areas is low and level, and the soil is water soaked and poorly drained. Before farming can be carried on it must be reclaimed by some system of drainage. A small proportion of the type has been drained more or less thoroughly by open ditches, which in some cases have been supplemented by tile drains.

The nature of the crops that can be grown on peat depends upon two factors, the drainage and the danger from frosts. When only a main outlet and lateral ditches have been installed hay crops alone can be safely grown in the great majority of cases, and the character of the hay crops will also depend a good deal on the drainage. In the case of peat underlain by sand, well-constructed and sufficiently deep ditches 40 to 80 rods apart will, in some cases, give adequate drainage for hay, but when the peat is underlain by silt or clay the ditches must not be more than 20 rods apart, and the water in the ditch must be 4 or 5 feet below the surface during part of the growing season. When tilled crops are to be grown, such as corn, cabbage, or potatoes, or a small grain, the drainage must be still more thorough, and over most of the peat this means a comprehensive drainage system in the form of either open lateral ditches or tile drains not more than 10 and often not more than 5 rods apart on the average. Tile drainage is the more satisfactory, but the cost amounts to $20 or $30 per acre after the main outlets have been put in.

It is well known that frosts frequently occur on the peat marshes when there is no frost at all on the higher land adjoining.

This is partly because the cold air tends to collect in low places, but also in part to the incapacity of the loose, spongy peat soil to conduct the noonday heat to as great a depth as do the earthy upland soils, and since the heat left in the surface inch or two is rapidly lost at night by radiation, the freezing point is frequently reached when it would not be on a sandy loam or clay loam soil. This difficulty can be overcome to some extent by compacting, and it will also decrease as the peat decomposes and takes on more of the character of muck. Nevertheless, it must always be expected that the marsh land will be more subject to late spring frosts and early fall frosts than the upland, and it may be stated as a general guide that killing frosts will occur at about the same time as in upland regions about 150 miles farther north, or two weeks or more earlier than on hilltops in the same latitude, so that such crops as corn and potatoes, while safe for the upland region, should not be depended upon as the chief crops on peat.

The native vegetation on the peat marshes consist chiefly of coarse marsh grasses, sedges and sphagnum moss on the open marshes, with willow, alder, some poplar, and tamarack in the timbered tracts. By far the greater proportion of the peat is still unreclaimed, but some tracts have been cleared and are being used for hay and pasture. The hay is made from the coarse marsh grasses, which have a considerably lower feeding value than the tame grasses. Wire grass from some marshes is marketed for making rugs and matting. In a few instances patches of peat have been drained and used for planted crops. Part of the area north of Waupaca is used for growing potatoes, cabbage, celery, onions, and other garden truck, and it is well suited to these crops. There is no reason why a larger proportion of the peat lands of this country should not be reclaimed and used for these and other cultivated crops, as well as for hay and pasture.

Peat, Shallow Phase.—The peat, shallow phase, is not nearly so extensive as the typical peat, although it is fairly well distributed throughout the county. It often forms the border between the highland and areas of deep peat, but some tracts are

made up entirely of the shallow phase. It differs only in having a depth of 18 inches or less, while the typical peat is usually over 3 feet deep. As in the case of the typical peat the subsoil is variable, conforming quite closely with that of the adjoining upland. The shallow phase probably contains somewhat more mineral matter than the typical, but none of the areas could be mapped as muck.

Very little of the shallow peat is under cultivation. It is used to some extent for hay and pasture, but only a few small areas have been reclaimed for cultivation.

In the improvement of the peat lands of Waupaca County the first step, of course, is drainage. With the exception of the marshes immediately along the Wolf River it is probable that much of the Peat can be drained and successfully cultivated. It will be necessary to use commercial fertilizers for a period of years, since the soil is deficient in both potash and phosphoric acid. It is abundantly supplied with nitrogen and organic matter, so that stable manure can better be used on upland soils where the nitrogen of the manure is needed. The use of a heavy roller to compact the soil is desirable. With thorough drainage, cultivation, and fertilization the peat soils will produce good yields of such crops as onions, cabbage, celery, alsike, and timothy. Soy beans can also be grown successfully, and they supply an abundance of nutritious feed.

Marlboro County, South Carolina.

By Cornelius Van Dyne and Others,
United States Department of Agriculture.

Muck.

Muck consists of a friable, smooth, finely divided, and quite thoroughly decomposed mass of organic matter, with an admixture of mineral matter consisting of silt, clay and some fine sand. As mapped in this county it carries little or no fibrous material.

Four areas of muck are mapped in Marlboro County. In Catfish Bay mucky material extends to a depth of 3 feet or more, and the subsoil apparently carries very little more mineral matter than the soil. None of this area is cleared and some of it supports the original timber growth. North of the Little Peedee River near the Dillon County line another small area of similar character is mapped. Part of this has been cleared and cultivated. The muck in Hilson and Mossy Bays may be best described as a shallow phase, as the mucky layer ranges in depth from 12 to 18 inches in the old clearings, although it is probably deeper near the center of the bays and their uncleared sections. The subsoil is very plastic, gray to mottled gray and yellow clay loam to clay, continuing to a depth of 3 feet or more.

Muck occupies a depressed position with respect to the surrounding soil types. The surface is flat. Small streams either head in the several areas or ditches, have been dug in order partially to drain them. A large acreage in the upper end of Hilson Bay has been improved with ditches so that the material does not remain swampy throughout the year. Over the remainder of the muck a swampy to semiswampy condition prevails, water standing on the surface for long periods and the material being saturated during the greater part of the year.

Part of Catfish Bay supports its original growth of scattered pine, with a fairly dense undergrowth of cane, vines, etc. The remainder has been recently logged off. In Hilson Bay the present timber is scattering cypress, gum, maple, and pine, typical of cut-over land. The part formerly cultivated supports a growth of wild grasses and weeds. Mossy Bay comprises mainly cut-over land on which there is a scattered growth of forest trees, vines and underbrush.

At present muck is not used for crop production. Approximately 1,000 acres in Hilson Bay were once in cultivation, but have been abandoned for years and are now used for pasture. The land is held at a low price.

The reclamation of muck by artificial drainage is in most cases practicable, as natural streams head in or near the areas. When this land is reclaimed it is adapted to the production of corn, cabbage, and other crops.

PROCEEDINGS OF THE FOURTEENTH ANNUAL CONVENTION.

Large and Successful Meeting at Madison, Wisconsin.

The Fourteenth Annual Convention of the American Peat Society was held in the Soils Building of the State University at Madison, Wis., on September 2, 3 and 4, 1920. It was one of the most successful meetings in the annals of the organization. The generous hospitality of Professor Whitson, of the University of Wisconsin, the excellent program that had been arranged, and the interesting papers presented all contributed to the occasion. The attendance was good and many members took advantage of the opportunity that was given them to visit nearby cultivated peat lands. (See Pl. I.) The Wisconsin State Drainage Association met jointly with the American Peat Society and thus added to the success of the convention. At the termination of the proceedings it was unanimously conceded that the community of interest which gave birth to the society had been enlivened and that the bonds of friendship upon which the success of the organization depends were more firmly and permanently cemented.

Convention Well Advertised.

The announcement of the convention was issued by Secretary Knap on August 12. In order to give the meeting local publicity and insure a large attendance the editor, on August 26, gave the following statement to the leading daily newspapers of Madison:

> The Fourteenth Annual Meeting of the American Peat Society will be held in Madison, Wis., on Thursday, Friday and Saturday, September 2, 3, and 4. All persons interested in peat, muck or humus will be welcome.
>
> The peat deposits of Wisconsin cover approximately 1,000,000 acres and are estimated to be capable of yielding 2,500,000,000 short tons.
>
> The deposits that have been tested vary from 1 to 20 feet in depth and are from 1 to 30,000 acres in area. Although Wisconsin ranks second among the States in the quantity of peat it contains, little has been done to use the peat commercially. The value of peat produced in the other States amounts to $1,000,000 annually.

The economic future of several counties in Wisconsin is directly dependent on the successful utilization of their peat supply. There is some peat in nearly all of the undrained areas, but the most important deposits are located in the following counties: Ashland, Dane, Dodge, Door, Florence, Fon du Lac, Green, Lake, Jefferson, Juneau, Kewannee, Langlade, Marinette, Marquette, Oconto, Oneida, Price, Rock, Sawyer, Shewano, Sheboygan, Vilas, Walworth, Waukesha, Waupace, Waushara, Winnebago, and Wood.

Papers will be read at the convention explaining the various agricultural and industrial uses of peat, muck and humus.

Many Interesting Papers Presented.

The following is an abstract of the daily proceedings:

Thursday, September 2, 1920.

The convention was called to order at 10:20 A.M., by President Thompson. Professor Morrison, of the University of Wisconsin, delivered the address of welcome, and Mr. L. B. Arnold, of Duluth, Minn., responded on behalf of the society. The following papers were read during the morning session:

"The Use of Tractors and Plows on Peat Lands," by O. R. Zeasman, of the University of Wisconsin (prepared in part by F. W. Duffee).

"Tile Drainage on Peat Land," by E. R. Jones.

An interesting discussion succeeded, which continued until adjournment for lunch.

The meeting re-convened at 2.15 o'clock P.M. and President Thompson announced the appointment of the following committees:

Committee on Resolutions.

M. M. McCool, Chairman,
Ezra Levin,
L. B. Arnold.

Committee on Nominations.

Henry W. Whipple, Chairman,
John Wiedmer,
H. C. Thompson.

The following papers were then presented:

"Experimental Work on Minnesota Peat Soils in 1920," by F. J. Alway.

"Development of Peat Industry in Indiana," by H. A. Huston.

At the close of the discussion elicited by these papers the meeting adjourned until 8.00 o'clock P.M. During the remainder of the afternoon many of the members visited the experimental peat farm of the University of Wisconsin and were shown a large variety of interesting tests.

At the evening session the following papers, illustrated by lantern slides, were presented:

"Truck Growing on the Muck Soils of the East," by H. C. Thompson.

"Roots Developed in Peat Land as Revealed by the Microscope," by Professor Elliott.

"Development of Swamp Land in Minnesota," by G. H. Payne, of Omaha, Neb.

After agreeing to meet at 9.00 o'clock A.M. the next day the convention adjourned.

Important Business Transacted.

Friday, September 3, 1920.

Pursuant to its agreement the convention assembled at the appointed hour with President Thompson in the chair and Mr. Whipple as acting secretary.

The annual report of the secretary-treasurer was read, adopted, and ordered printed in the journal.

The attention of the members was then directed to the following proposed constitutional amendment presented at the Thirteenth Annual Convention held at Minneapolis, Minn., in 1919:

Be it enacted that the president be given the power to increase the executive committee to nine members, exclusive of the officers, that active members be favorably considered for this committee, and that it transact business by mail and telegraph.

Members of the American Peat Society on excursion to peat experimental farm.

After some discussion a vote was taken and the amendment was lost.

The resolutions of the Executive Committee relating to the resignation of Dr. Herbert Philipp as editor were then read, accepted, and ordered printed in the journal.

The following resolution was next offered by the Committee on Resolutions, adopted, and ordered printed in the journal:

Be it resolved that the members of the American Peat Society extend a vote of thanks to the Wisconsin State University College of Agriculture in appreciation of the splendid hospitality accorded to them, and that special thanks be extended to Professor Whitson for arranging the program and selecting timely subjects for discussion.

A resolution reading as follows was offered:

Be it resolved that the society consider the feasibility of associate membership, with nominal dues in order that the journal may have a wider circulation and thus be of greater service.

After a brief discussion a motion was made and carried referring the latter resolution to the Executive Committee for appropriate action.

The Committee on Nominations reported as follows:

We, the Committee on Nominations, hereby respectfully suggest the following persons for officers and members of the Executive Committee during the ensuing year:

President—Professor A. C. Whitson, Madison, Wis.
First Vice-President—Professor C. S. Robinson, East Lansing, Mich.
Second Vice-President—Myron W. Robinson, New York, N. Y.
Secretary-Treasurer—Chas. Knap, New York, N. Y.

Members of the Executive Committee:
John N. Hoff, New York, N. Y.
G. Herbert Condict, Plainfield, N. J.
Professor H. C. Thompson, Ithaca, N. Y.
Dr. Herbert Philipp, New Brunswick, N. J.
Clarence C. Osbon, Ponca City, Okla.

(Signed)

HENRY W. WHIPPLE,
JOHN WIEDMER,
H. C. THOMPSON.

A motion was made and adopted that the foregoing report be accepted without change. It was then moved and ordered that the nominations close and that the secretary be instructed to cast the ballot of the society for the nominees. The vote of the membership present was so cast and the persons nominated were elected for the ensuing year or until such time as their successors might be chosen.

A paper was submitted by the Federal Service and Development Systems, Inc., explaining the use and possibilities of a peat machine manufactured by that company. A motion was made and adopted that the paper be referred to the editor for printing in the journal and that likewise all the foregoing papers be so referred.

An invitation was received from the University of Michigan Agricultural Experiment Station to hold the next conventon of the Society at East Lansing, Mich. Upon motion it was ordered that the proposition be referred to the Executive Committee for appropriate action.

The following papers were then successively read by their authors:

"The Relative Suitability of Various Crops to Peat Lands," by H. W. Ullsperger.

"Truck Growing on Muck Soil of the Kankakee Marsh in Northern Indiana," by J. H. Beattie, of the U. S. Department of Agriculture.

"Knowledge to be Obtained from the Practical Farmer," by Ezra Levin.

"Peat for Fuel," by Herbert Garnett.

Attention was directed to the field trips planned for the succeeding day. There being no further business, the convention adjourned.

Interesting Peat Lands Visited.

Saturday, September 4, 1920.

Several members of the society, under the direction of Professors Jones and Zeasman, visited the peat deposits in the vicinity of Madison, and others under the guidance of Professor Whitman made an excursion to the large peat farming districts near Hancock. All reported an interesting and profitable trip.

PROCEEDINGS OF THE EXECUTIVE COMMITTEE.

By Chas. Knap.

At a meeting of the Executive Committee held in New York, N. Y., July 27, 1920, Dr. Herbert Philipp tendered his resignation as editor of the journal. This action was necessitated by reason of the pressure of professional duties. The resignation, which became effective October 1, 1920, was accepted with sincere regret, and Clarence C. Osbon, formerly in charge of the peat work of the United States Geological Survey, was unanimously chosen to assume the editorship. As an expression of the appreciation of the society for the faithful service rendered by Dr. Philipp, the following resolution was prepared by the Executive Committee for the consideration of the society at its Fourteenth Annual Convention at Madison, Wis.

Whereas Dr. Herbert Philipp has resigned the editorship of the Journal of the American Peat Society, a position filled by him with unusual ability and distinction, both as associate editor from the foundation of the society in 1907 to 1912, and as an editor since the latter year; and

Whereas he has won universal confidence by endeavoring to benefit the industry with his knowledge and by fostering free discussion in the journal of all questions pertaining to peat,

And whereas he has given his time and ability without remuneration to the improvement of the journal until it has attained wide recognition as an authority on peat;

Be it resolved that a vote of thanks by the members, in convention assembled, be extended to Dr. Philipp for all that he has accomplished for the welfare of the society;

That upon the relinquishment of his duties the members extend their best wishes for continued professional success and prosperity and express their gratification in still having his counsel as a member of the Executive Committee available to them;

And that these resolutions be printed in the journal as an expression of their high esteem for him and as a public tribute to his great ability as an editor and a scientist.

A special meeting of the Executive Committee, called at the request of two of its members, was held at 1134 Broadway, New York, N. Y., Wednesday, October 13, 1920, at 10.00 o'clock A.M. The following members were present:

J. N. Hoff, *Chairman,*
Myron W. Robinson,
Herbert Philipp,
Clarence C. Osbon,
Charles Knap.

There being a quorum, the meeting was called to order by the chairman.

The minutes of the preceding meeting were read and approved..

Dr. Philipp called attention to the long delay in obtaining important governmental data concerning the peat deposits of the United States. Although an exhaustive report was prepared more than a year ago by E. K. Soper and C. C. Osbon for the United States Geological Survey, Washington, D. C., the data have not been published. Many communities are suffering detriment from the lack of accurate complete information relative to the quantity, uses and value of their peat deposits for fuel, fertilizer, and crop soils.

Upon motion the following resolution was passed:

Be it resolved that a letter be addressed to Dr. George Otis Smith, Director of the United States Geological Survey, calling his attention to the delay in publishing the report by E. K. Soper and C. C. Osbon describing the vast peat deposits of the United States, pointing out the importance of their development to the country, and outlining the uses for which the peat is best adapted.

And be it further resolved that a copy of this letter be mailed to all members of the society asking them to co-operate in this movement by forwarding the letter, accompanied by one of their own, to their congressman, urging that he recommend the prompt publication of the report by the Geological Survey.

Accordingly a letter was addressed to the Director of the Geological Survey on October 16 and on October 21 a letter was sent to each member of the society.

The following is the reply received from Dr. Smith:

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY
WASHINGTON

October 20, 1920.

MR. CHARLES KNAP, *Secy.*,
American Peat Society,
17 Battery Place,
New York, N. Y.

Dear Mr. Knap:

In reply to your letter received October 16:

You will, of course, understand that the report, "Occurrence and uses of peat in the United States," is only one of many prepared for publication in the last few years and that each of these reports must take its turn in the hands of the editorial staff and also in the hands of the Public Printer in the order of its relative importance rather than in the order of its date of preparation. *It is to be regretted that funds available for the editorial work of the Geological Survey are not larger and that more prompt publication of all Survey reports can not be made.*

Yours very truly,
(Signed) GEORGE OTIS SMITH,
Director.

In view of this letter it occurred to some members of the Executive Committee that it might be in the interest of better administration to conduct field investigations only as their results could be made available to the public and to divert some of the money that it being spent in field work to the publication of existing reports in order that the present congestion might be relieved and that the reports might be more timely.

Mr. Osbon said that the success of the society was directly dependent upon an increase in its membership, and recommended that brief press bulletins be published in appropriate newspapers calling attention to the location and commercial possibilities of the peat and to the scope and objects of the American Peat Society. Accordingly the following resolution was passed:

Be it resolved that Messrs. Robinson and Osbon be appointed a committee to increase the membership of the society and the circulation of the journal by bringing them more widely to the notice of the public by means of brief press bulletins, and that they use their influence in having these notices printed as news items.

Mr. Hoff called attention to the present high freight rates in effect between some points for the transportation of peat (known commercially as humus) in carload lots as an ingredient of commercial fertilizer. He contended that some of the present tariffs hampered the development of the industry by curtailing the output due to its high cost to the consumer. Upon motion the following resolution was adopted:

Be it resolved that the secretary be instructed to address letters to the Interstate Commerce Commission, Washington, D. C., and to the general freight agents of railroads serving areas where peat (or humus) shipments originate and connecting lines, requesting a readjustment of existing tariffs, in order that a more equitable commodity rate might be established and that the wider distribution of peat (or humus) as a fertilizer ingredient and a substitute for the diminishing supplies of manure might be promoted.

There being no further business, the committee adjourned.

ABSTRACTS OF PATENTS.

By William P. Perry.

Distilling Peat.

This invention describes a distilling apparatus, which consists of a vertical container provided with a series of abutments at different elevations constructed on the inner walls. These abutments provide means for collecting gas and adjacent to the lower end of the container is a grate above which the inner walls of the container are lined with refractory material. Poke holes are provided above the grate and means are provided on the side of the container for removing the accumulated gases. Below the grate provision is made for introducing gas and steam, which passes through the material after it has been treated. Part of the gases generated are passed under the grate and assist in treating the material.—U. S. Patent 1,341,517.

Treating Soil.

By W. E. Davies.

In a process for treating land or soil, either on a large or on a small scale, by the introduction of liquid, dissolved, or gaseous plant nutriment, a bed is formed below the soil comprising a lower layer of brick, briquettes, rock, tiles, etc., and an upper layer of carbonaceous or organic material like peat, preferably moulded into slotted or grooved briquettes. The nutrient is supplied to the lower layer through a piping system provided with the usual cocks and supply pipes communicating with reservoirs and the like. A drainage layer with pipes may be situated below the piping system. Vertical perforated pipes may extend from the bed to the air above. The system may be used to supply liquid nutriment, such as dissolved fertilizer in the form of ammonium sulphate, ammonium nitrate, nitrites, sodium nitrate, calcium phosphates, sulphates, carbonates, carbohydrates, sili-

cates, and dilute bases, or gaseous nutriment such as air, waste gases, sewage gas, products of combustion, ammonia, etc. The nutriment may be heated before being passed into the supply system, and the liquid nutriment may be bacterized. As examples of bacteria, azotobacter chroococcum, nitroso and nitro bacteria, anaerobic bacteria and pseudomonas radicicola are mentioned. The piping system may be used for drainage, with or without suction being applied.—British Patent 142,953.

Fertilizer with Peat.

A fertilizer is obtained by mixing moist ammonium nitrate and pure or commercial potassium chloride either in equal molecular proportions or with the potassium salt in excess. Double decomposition takes place, yielding a non-deliquescent, non-explosive mixture of potassium nitrate and ammonium chloride. The mixture is dried and mixed in any suitable or desired proportion with peat.—British Patent 145,036.

Peat-Drying Apparatus.

By M. C. Olsson.

To facilitate the extraction of water therefrom, peat is heated in a closed vessel and a sudden expansion of the resulting vapor is effected by suddenly causing a reduction of pressure in the vessel. When the peat is heated under a pressure greater than atmospheric, the heated peat may be discharged suddenly into a chamber under æatmospheric pressure. An apparatus suitable for use in treating the peat when the pressure in the heating-vessel is below atmospheric is illustrated in the accompanying sectional elevation. The heating-vessel has a peat-inlet valve and a discharge valve, pressed against its seat by a spring contained in a housing, which is pivoted to a vessel by means of a spindle provided with a handle. A spring-pressed lever, actuated automatically by a lever and a cam, serves to lock the valve in its closed position while the peat is being fed into the vessel and heated. The heating is effected by hot waste or other gases cir-

culating through a helical flue in a jacket, surrounding the vessel; the gases enter the flue through an inlet pipe and leave by an exit-pipe. The lower part of the vessel projects into a vacuum chamber fitted with a screw discharging-means and a peat-discharging valve. The upper part of the chamber communicates with a vacuum ejector, operated by water supplied through a pipe and having a long discharge pipe. Communication between the chamber and the ejector is opened and closed by means of a rotary valve on the spindle of which the cam is mounted. The vessel is filled with peat which is heated to about 100° C, and the valve is then closed. The valve having been opened and the valve having been closed, a vacuum of about twenty-four inches is produced in the chamber by means of the ejector. After closing the valve simultaneously releasing the valve by means of the cam and lever, the peat is suddenly discharged into the chamber, and from this chamber by the discharging-means, after opening the valve.—British Patent 147,286.

Purification of Peaty Water.

By Ernest G. Blade.

The discharge from the pumps is immediately passed through clean chalk, which has been broken to pass a 3-inch ring and is free from dust. The humic acid which attacks pipes and fittings is thereby removed from the water. The chalk becomes inert after a time and must be renewed periodically. The water is usually passed through a small sand filter prior to use.—Sci. Progress, 1920, Vol. 14, p. 659.

CURRENT COMMENT.

The Elusive Bacteria.

Research continues both in this country and in Europe in the development of helpful varieties of soil bacteria, leguminous and non-leguminous. A Chicago doctor is the latest candidate for fame, with a liquid culture which is to work wonders when applied to growing crops. The subject is an attractive one, and it is desirable that we should know more about these creatures, which undoubtedly play an important part in plant growth.

The only practical achievement of the scientists thus far has been the successful inoculation of leguminous seeds. This in itself warrants further investigation, but a number of promising laboratory methods have, during the past four or five years, proved to be failures when tried in the field. A soil well supplied with humus and plant food seems to develop enough bacteria without assistance. When the artificially propagated bacteria are introduced into a soil deficient in humus and plant food they seem to disappear. Perhaps they starve to death.

The farmer works in fields, not in laboratories. When any discovery is made that is helpful to field crops we shall promptly record it.—*The American Fertilizer.*

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THE MANUFACTURE AND UTILIZATION OF PEAT FUEL[1]

By Benj. F. Haanel,
Canadian Department of Mines.

Introduction

Means and ways for utilizing the vast quantities of heat energy lying dormant in the peat areas of the world would in all probability attract but little attention today were it not for the fact that people generally are beginning to realize that the world's stores of solid and liquid fuels are limited in quantity, and that with certain of them exhaustion is within sight. In no age have all the natural resources been exploited on so stupendous a scale, and not since the advent of man on this arth has his prosperity and very existence been so inseparably linked with certain of them. Yet, knowing these facts, the very sustenance of his life and welfare is being drawn upon at a most alarming rate and, it must be said, in a most prodigal manner.

This is an era of phenomenal industrial activity based on the marvelous development of the sciences, and future historians will perhaps describe this period as the mechanical age. Directly, however, the great achievements of today are due to the ability we possess of generating power in almost unlimited quantities, and the length of the life of this most spectacular epoch will be measured by the life of mechanical power.

The immense deposits of the various classes of coals have for

[1]Read on June 29, 1920, at a meeting of the American Institute of Chemical Engineers in Montreal, Canada.

so long a time supplied man with a cheap and easily obtainable fuel particularly suited for metallurgical purposes and the generation of power that but little or no thought has been given to the utilization of the lower grade fuels which perhaps in but a comparatively short time will have to serve as a substitute for both the high-grade coals and petroleum. Peat, the subject of this paper, is one of the lower grade fuels, and so far as heating value and difficulty of winning are concerned, perhaps it might be described as the lowest grade of fuel.

Origin of Peat

Peat is a combustible substance produced by the slow decomposition of vegetable matter covered or saturated with water. The character and quality of the peat depends on the conditions prevailing during the period of decomposition and on the nature of the vegetation taking part in its formation. The peat-forming vegetation comprises practically all the mosses, (especially *Sphagnum and Hypnum*) heath plants, sea and swamp plants such as rushes, sedges, and grasses, and to a limited extent the trunks, roots, and leaves of trees. According to P. R. Bjorling and F. T. Gissing peat formation is accounted for in the following manner:

During the growth of the plants the interior walls of the cells are gradually coated with substances which ultimately became so thick as to impede the free transpiration of oxygen and aqueous vapour, the result of which is a lowered vitality and finally death of the cell. At this stage the plant generally begins to decompose, the contents of the cell disappearing first, then the cell wall, and lastly the spiral fibres. These steps are marked by characteristic chemical changes. The retention of oxygen in the compounds at the time of death promotes fermentation, especially of the nitrogenous compounds which yield ammonia, sulphuretted hydrogen, and phosphoretted hydrogen. The non-nitrogeneous compounds, such as the sugars and starches, are converted into the various acids generally produced by decaying vegetable matter. In the course of time the cells become so distended with the products of decomposition that their walls burst, permitting the various gaseous compounds to escape. With this new condition the further chemical changes assume a different character. The unaltered vegetable matter is converted into humic and allied acids and carbonic acid and the soluble compounds pass away in solution. Finally the cell is emptied of its contents and deprived of its green colour if it originally contained chlorophyll. During the next stage the decomposition of the cell wall takes place. This proceeds more or less rapidly, depending

on whether or not it is incrusted with slightly soluble lime salts, silicates, and resinous matters, and also on the strength of the vegetable acid solutions in which it is immersed. As a result of the evolution of oxygen, aqueous vapour, and carbon dioxide, the resulting mass contains a large and increased proportion of carbon, a small amount of hydrogen, and some oxygen in a combined form, generally as a yellow-brown ulmin; but often this is subsequently converted by oxidation into the light brown humin. At this stage in the process the vegetable matter consists mainly of a mixture of ulmin, humin, and spiral fibres. During the final stage the destruction of the spiral fibres and more resistant tissues is greatly assisted by the combined action of frost and moisture. Frost disintegrates the fibres and the black mould-like substance absorbs so much water that it becomes water-logged and sinks to the bottom of the pool in which it is formed. By the accumulation of an overburden of additional matter resulting from like decomposition, this altered substance is subjected to pressure, slow carbonization, and to permeation by bituminous and resinous compounds, and after a time is converted into what is commonly known as peat.

In order that the above process may proceed as outlined, free access of air must be excluded; otherwise the residue would be gradually oxidized and only the inorganic components left. In the case of a peat bog, however, the material is immersed in water, free excess of air is consequently excluded, and the process outlined above results in the gradual accumulation of peat, which increases in carbon content at a rate depending on the rapidity with which humification proceeds. The older the peat formation the greater the degree to which humification has proceeded, depending of course, on the character of the vegetation forming the different peat layers. The deeper layers of the older peat bogs generally are composed of brown to black, heavy, and well-humified peat, and the deepest layer of brownish black, dense peat containing very little recognizable vegetable remains. This class of peat possesses the highest fuel value.

Physical Properties

Peat, as it occurs in undrained areas, is a mixture of water and partially decomposed and disintegrated vegetable matter of varied origin. The quantity of water associated is generally sufficient to saturate the vegetable matter, and constitutes from 87 to over 90 per cent of the weight of the mixture. Even in a well-drained bog the water content seldom falls below 87 per cent, and as long as any water remains in contact with the

bottom layers the entire peat mass, with the exception of the surface which is continually exposed to the sun and wind, tends to assume the condition of saturation. The water content is therefore the most obstinate stumbling block to the successful utilization of this valuable fuel resource.

Peat is an exceedingly variable substance. Not only are two bogs, situated comparatively near to one another, likely to differ in composition, but the various layers of an individual bog sometimes possess marked differences. With increase in age and in the depth of the bog such differencs, of course, become less noticeable and finally disappear. Their variation, however, does not seriously affect the value of a bog for fuel purposes, but they do assume importance when it is desired to utilize the peat content for some special purpose.

The color of peat ranges from light yellow, through various shades of light brown, reddish and dark brown, to jet black. All peats look darker when they are saturated with water, but the lighter shades become much darker when the peat is macerated and exposed to the air. This blackening is due to the partial oxidation of the more complex organic compounds to simple ones, and the consequent liberation of certain gaseous compounds.

The specific gravity varies greatly with the different types of peat. Figures determined by various authorities for the absolutely dry peat range from 0.1 for the very fibrous and poorly decomposed varieties to 1.06 for the heavy, compact and thoroughly decomposed, black types. The peat bogs so far examined in Canada also exhibit considerable variation as regards the specific gravity and density of the peat. But this subject has not yet been thoroughly investigated and consequently reliable figures are not available. The specific gravity of raw peat from the Alfred Bog is in the neighborhood of 1.01.

The content of inorganic matter which constitutes the ash also varies greatly and depends almost entirely on the conditions prevailing when the different layers of the peat were formed. The ash content, though usually low, may in some deposits be so high that the peat is useless for almost any purpose. But the ash found in the normal bog does not present any difficulties when the peat fuel made from it is burned for domestic or industrial purposes.

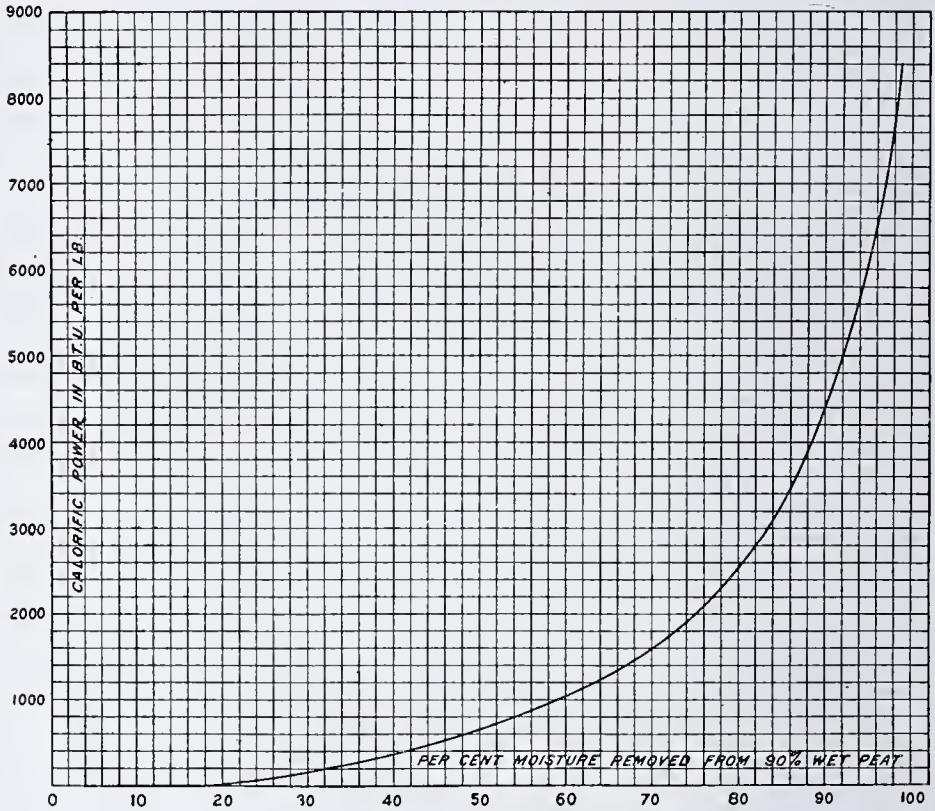

Fig. 1. Curve showing the effect on the calorific power of wet peat by removing different percentages of the total moisture content.

Chemical Properties and Calorific Value

Peat, unlike the true coals, has a high oxygen content varying from 30 to 40 per cent, a carbon content ranging from 50 to 60 per cent, and a hydrogen content of from 5½ to over 6 per cent. Nitrogen in varying amounts is found in practically all peats, but in certain cases is unusually high. The nitrogen content of all the peat bogs in Canada so far examined is over one per cent, and in several of them it nearly equals or exceeds 2 per cent. In other countries peat bogs are known in which the nitrogen content is even higher than this, and in one bog in the Province of Ontario, Canada, the nitrogen varies from 2.5 to 2.8 per cent, determined, of course, by the analysis of absolutely dry peat. Nitrogen in peat assumes great importance when the fuel is considered from the standpoint of its value for the generation of a producr gas for the production of power or for the production of peat coke. The following is a typical analysis of Canadian peat:

Carbon	56.0
Hydrogen	5.2
Ash	6.0
Oxygen, nitrogen, and sulphur (computed)	32.8

Phosphorus and sulphur occur to a limited extent in all peat bogs. In Canadian bogs these elements vary from 0.026 to 0.087 for the former, and from 0.218 to 1 per cent for the latter. The higher phosphorus and sulphur contents, however, are only met with in isolated cases and may be regarded as unusual.

The calorific value of absolutely dry peat varies from 8,000 to 9,500 B. t. u's. per pound. These values pertain to Canadian peat bogs. In other countries, notably Ireland, a heating value of over 10,000 B. t. u's. per pound is not uncommon.

Since peat fuel in the absolutely dry state is never utilized for domestic or industrial purposes, the values above stated are of little significance. The net calorific value is the only one which need be considered. Figure 1 shows the effect which the moisture content of the fuel has upon its calorific power.

Colloidal Property of Peat

For some time certain investigators who devoted much time

to the study of peat held the opinion that the water content was almost entirely held by a complex hydro-carbon termed by them hydrocellulose, which substance possesses the property of absorbing many times its own volume of water, and that peat would not part with its water content by pressing until the colloidal properties of this substance had been destroyed. The name hydrocellulose was given by Ekenberg to a gelatinous hydrocarbon which occurs in all humified peats, to a certain extent, and this hydrocarbon, like all gelatines, possesses an enormous capacity for absorbing water. This substance, moreover, is a true colloid, but the destruction of its colloidal properties or its extraction from the peat mass does not perceptibly affect the capacity of the peat for absorbing water, nor render it in such condition that it will part with its moisture by pressing. The fact is that the better and older, humified peats are themselves colloids, or at least possess colloidal properties, and it is these properties which make it physically impossible to separate the water content, to any great extent, by mechanical means. It is necessary, therefore, to destroy the colloidal properties of the peat itself if it is desired to attempt to separate the water from the combustible substance by means of pressure. As will be shown later, all attempts to convert the raw peat into some condition which would permit of the water being separated have failed, at least economically.

Manufacture of Peat Fuel

Before discussing the economic methods utilized today for converting raw peat into a usuable commercial product, it is important to discuss at some length processes which have been tried but which have not proved successful, inasmuch as certain of them not only involve the employment of artificial heat but also pressing by means of either the hydraulic or filter press.

Ekenberg was probably the first investigator who realized that raw peat would have to undergo some change before it could be hoped to separate its water content by pressing, and in order to achieve this object he devised a process known as the "Ekenberg Wet Carbonizing Process." By this process the raw peat saturated with water is heated under pressure in a closed retort. A chemical change is effected; the carbon content is

increased and some of the hydrogen of the peat combines with the free oxygen, forming water and thereby increasing the water content. No gases are evolved during the period of heating, as in the case of dry distillation; hence none of the combustible components of the fuel are lost. After the peat has been carbonized in this manner it is subjected to pressure. While, as a result of the carbonizing, the altered peat does submit more readily to pressing, the increased quantity of water which can thus be separated is, in my opinion, not sufficient in amount to enable this process to be conducted commercially. After carbonizing and pressing it is still necessary to employ artificial heat to evaporate the remaining moisture. Efforts are, however, still being made to adapt this process to the manufacture of peat fuel on a commercial scale.

Efforts which have occasioned the loss of large amounts of money have also been made to separate the bulk of the water content by artificial drying; first, by the direct application of heat as in direct heat dryers; second, by the passing of heated air over and through the mass of wet peat to be dried; and third, by blowing large quantities of air at atmospheric temperatures (60° F. and over) over and through wet peat. This last method could only be employed in warm weather. But all of these methods fail when attempts are made to remove the bulk of the water content in this manner, since there are not sufficient heat units in the combustible substance of one pound of raw peat containing 90 per cent of water to evaporate the water alone (assuming a dryer efficiency of 100 per cent). Before artificial drying by any method whatever can be attempted the water content of the peat must first be reduced to 50 per cent or below. In order to reduce the moisture to 50 per cent every ton of wet peat containing 200 pounds of combustible substance and 1,800 pounds of water must have 1,600 pounds of water removed by means other than the employment of artificial heat.

In the manufacture of peat fuel great care must be exercised to reduce to the lowest possible limit the quantity of heat which may be required in the process. The reason for this will be plain when the nature of the raw peat substance is thoroughly understood and the low heating value of the combustible substance is appreciated. If peat fuel is to serve as a substitute for coal the cost of manufacture must be kept sufficiently low to

enable it to compete with coal in the open market on a heat unit basis. The ratio of the theoretical heating value of anthracite coal and peat, when the latter is sold with a moisture content of 25 per cent is approximately 2 to 1. It is, therefore, clear that the process employed for manufacturing peat fuel for industrial and domestic purposes must not entail the expenditure of large quantities of heat nor excessive handling. And in general, ideas of separating the water content by pressing, or of destroying the colloidal nature of the raw peat by the employment of electrolytes, must for the present be abandoned.

Air-Dried Machine Peat

For several centuries peat fuel has been utilized on a limited scale by the peasant class of those European countries possessing peat bogs, and even today comparatively large quantities are prepared by the farming class for supplying their own requirements. The method then employed, and which is still used in certain places, is exceedingly primitive, and the resulting fuel is inferior in quality as regards its physical properties. This method consists of cutting peat sods and laying them on the surface of the bog for drying, without any further treatment or manipulation. The resulting fuel is consequently exceedingly bulky, in most cases, friable, and can therefore, stand but little handling.

The discovery that puddling, grinding, or mastication, very greatly improved the quality of the fuel as regards its density, resistance to re-absorbing moisture, when once dry, and to breakage, led to the invention of a process known as the air-dried machine peat process, or as it is sometimes called, the wet process. This process had its beginning in a very primitive way, but through succeeding years, with the introduction of machinery and mechanical power, it was gradually improved until it reached the state of perfection it enjoys today. The most marked improvements have, however, been made within the past few years.

The process, as it is employed today, depends first of all on the forces of nature—the sun and the wind—for the removal of the bulk of the moisture. The method employing these forces is called the wet process and the product is termed machine

peat. This is the process which the Mines Branch, Department of Mines, demonstrated with the Government peat plant at Alfred some eight years ago, and is also the process which the Peat Committee, appointed by the Federal and Ontario Governments, is employing for the purpose of ascertaining whether or not peat fuel can be manufactured on a commercial scale under the conditions at present obtaining in Canada. The wet process consists of the following steps: first, the excavation of the raw peat by hand or specially designed mechanical excavators; second, the transfer of the excavated material to the hopper of a specially designed macerator; third, the transfer of this pulped peat to the portion of the bog prepared for drying purposes; and fourth, the cutting of the spread peat, when sufficiently set, transversely and longitudinally into blocks, which, when dried to about 25 to 30 per cent moisture, have the dimensions of ordinary building brick.

The macerator which performs perhaps the most important function of the entire process consists of a cylindrical shell, inside of which is a set of spiral rotating knives and a set of knives fixed to the inside of the cylinder. The material fed to the hopper is forced by the spiral knives through and against the fixed knives. The fibers, roots, and pieces of wood which are often found throughout the bog are cut, torn, or ground into small fragments and the peat composing the different layers of the bog and the gelatinous hydrocarbon previously referred to are thoroughly mixed, producing a homogenous mass. The degree to which pulping is carried is determined by regulating the opening of the spout through which the pulped material has to pass.

During the drying stage the gelatinous content of the peat performs a very important function. It serves to bind the particles of peat together and prevents the peat blocks from re-absorbing moisture when the drying period is interrupted by wet weather. This property is due to the fact that the colloidal substance forms a skin-like cover on the outside of the block, and that this skin always assumes a state of complete saturation until the peat block is thoroughly dry. Hence, it acts as a vehicle for conveying the moisture from the inside of the peat block to the atmosphere. Thus the moisture evaporated from the outside of the block by the sun's heat is immediately balanced

by moisture drawn from within and a state of equilibrium is therefore always maintained until the drying is complete. During rainy weather the reverse takes place; the rain brings the skin to its maximum saturation thus preventing moisture from reaching the interior of the block. As a result of the uniform distribution of the gelatinous material throughout the peat block, contraction takes place as the drying proceeds and the blocks become denser and more resistant to breakage. This characteristic is notably lacking when the peat is manufactured without maceration. When the peat blocks have partially dried on one side they are turned to hasten the drying on the under side. It was formerly considered necessary to pile the peat blocks in small cubes before drying was complete, but as a result of our investigations we have found that this step can be dispensed with. The harvesting or gathering of the dried peat blocks from the field must be performed to a very large extent by hand labor, assisted by power driven conveying machinery.

The above constitutes the various operations which must be performed in the manufacture of air-dried machine peat and all known, successful processes for manufacturing peat fuel on an economic basis, today, closely follow the various steps outlined.

Up to the beginning of the war a very large quantity of peat was produced in the peat countries of Europe, notably Russia, Sweden, Denmark, and Holland by treating hand dug peat in the above manner, and the plant originally installed some years ago near Ottawa by the Mines Branch of the Department of Mines for purposes of demonstration was similar to those employed in Europe at that time. Under the conditions obtaining some seven or eight years ago it was demonstrated that peat fuel could be manufactured at a cost which would permit it to compete with coal, but since that time the cost of labor and of material have increased to such an extent that, so far as Canada, at least, is concerned, the old hand method of excavating the raw peat could not be employed. In order to manufacture peat fuel on a commercial scale today it is necessary first of all to construct machines which will enable the greatest possible capacity per hour to be obtained with the employment of the smallest possible number of men.

A. Anrep plant in operation at Alfred, Ontario.

B. Moore plant excavating, macerating, and spreading machine peat fuel on the surface of the bog.

TYPES OF MODERN PEAT FUEL MACHINES

With a view to ascertaining whether or not machines could be constructed which would perform these operations at a sufficiently low cost to enable the manufactured peat fuel to compete with coal for various purposes the Peat Committee already mentioned was appointed. After thoroughly considering the problems to be solved this committee decided to construct two types of peat machines, one according to the Anrep system, and the other according to the Moore system. Plate I shows the two machines at work. The machine designed according to the Anrep system is equipped with a mechanical excavator which moves to and fro on a fixed track carried by the main platform of the machine. This track is placed at an angle of 45 degrees to the direction of travel of the excavator platform. This enables all standing walls to be left on a slope, which is a highly desirable feature where a heavy machine must be supported close to the excavation. The peat is automatically conveyed to the macerator and from this is discharged into cars which travel around a track system operated by cable traction from the main machine. These tracks extend to the full width of the drying field, about 800 feet, and the cars discharge into the hopper of a spreader which is operated by a gasoline motor. This spreader lays the peat out in rows 800 feet long. The completion of a row of spread peat necessitates the movement of that portion of the track lying adjacent to it; thus, during the day the track must be shifted six or seven times depending of course on the number of rows laid, and the entire rectangle of track must be shifted every three or four days.

In order to overcome the necessity of employing a track system of this description and the consequent expense of moving it after the completion of every row, Moore designed a machine equipped with an excavator which cuts parallel to the direction of travel of the machine. This excavator cuts to only a shallow depth; hence the forward movement of the entire machine is much greater than that of the type described above. The main feature, however, of Moore's machine is the employment of a light bridge work 160 feet long attached at right angles to the main platform of the machine and which moves as an integral part of it. The platform and bridgework are supported and propelled by three parallel caterpillar elements, the driving mechanism being arranged so that all three move

forward with exactly the same speed. Provision is made, however, to vary their speed to permit the machine being steered in its course when the working face is not a straight line. This bridge carries a belt conveyor and is also provided with spreading and harvesting devices which can be attached to it where desired. At the outboard end of the bridge a light elevator is attached which receives the dry peat travelling on the belt and deposits it in a store pile or in the small tram cars employed for harvesting. The caterpillars permit the machines to move over the field under their own power, thus obviating the necessity of laying track, as had to be done with the original Anrep machine. The peat excavated by the Moore machine is fed into the same type of macerator as is employed on the Anrep machine and is automatically discharged from the macerator into a hopper which in turn empties on to the belt conveyor. By means of a suitable sweeping device the belt conveyor is made to discharge at any desired point. It will be seen from the illustration that the peat is layed out parallel to the direction of travel of the peat machine in rows equal in length to the working face on which the excavator operates. In the case of this machine the working face is 8,000 feet long, hence the row of peat is 8,000 feet long by about 12 feet wide. When one row is completed the spreader is moved forward 12 feet and placed on the opposite side of the bridge for spreading the peat in the second row. The machine is symmetrical and works equally well in either direction. The device for transporting the pulped material to the spreader, which is equipped with an automatic device for cutting the spread peat longitudinally and transversely into suitable blocks, enables a very marked saving to be made in the number of men it is necessary to employ. In the case of the Anrep machine the spreading system requires 9 men, compared with only one man for tending the spreading of the same quantity of material with the Moore system.

The power plant of each machine consists of a water tube boiler of 80 horsepower capacity designed for burning peat fuel, and a number of vertical double cylinder steam engines for supplying the power to move the caterpillars driving the excavator and macerator. Both of the plants were designed to produce an average of six tons of finished peat fuel per hour containing 25 per cent moisture, or 60 tons during a

working day of ten hours, but with the improvements which have been made from time to time it appears that this capacity will be exceeded in both plants. The consumption of fuel in the boilers is approximately three tons each every ten hours.

Information concerning the cost and value of these machines for the commercial manufacture of peat fuel cannot be given to the public until the official report of the Peat Committee has been issued. But it can be said that the results so far obtained are exceedingly promising.

Drying of Peat

An investigation is also being conducted to determine the rate at which drying takes place during the operating period and also for the purpose of determining definitely when the operations can be begun and when they will have to be terminated. This investigation is not yet complete. As a general rule, considering the average summer season in this latitude, it should be possible to manufacture peat for 100 days, including the days lost when it is too wet to perform the operations on the field. To dry peat containing 90 per cent of moisture, the average content of the macerated peat at Alfred, to 25 per cent moisture requires about four weeks. This period is of course lengthened or shortened by rainy or exceptionally dry weather. Attempts were made to shorten the drying season and at the same time increase the output of the machines by completely draining the working trench. This resulted in a decrease in the moisture content of the peat to approximately 87½ per cent, which is the moisture content of the peat in the bog. The peat containing 90 per cent of moisture is due to the free water which is carried by the buckets of the excavator with the excavated peat. The working trench heretofore always contained two or more feet of water and it is this water which was drained off. A decrease in the moisture from 90 per cent to 87½ per cent by this means resulted in an increase in the dry peat substance of 25 per cent; so that for every ton of peat spread on the field there was 250 pounds of absolutely dry peat substance, whereas with 90 per cent water there was only 200 pounds of dry peat substance. The increase in output and the large decrease in the quantity of water which will have to be removed by air drying when the moisture content of the raw peat is reduced to 87½ per cent

will be better appreciated by the following illustration. In order to produce one ton (2,000 pounds) of peat containing 25 per cent moisture, enough raw peat will have to be excavated to supply 1,500 pounds of dry peat substance. Consequently if the raw peat contains 90 per cent water, the quantity of material which must be excavated is $^{1500}/_{200}$, or 7½ tons. The water content of 7½ tons is 13,500 pounds. With peat containing 87½ per cent of water, the raw substance will contain 250 pounds of dry peat substance and 1,750 pounds of water. The quantity of raw peat required will in this case be $^{1500}/_{250}$, or 6 tons. The quantity of contained water will be 6 times 1,750 or 10,550. Therefore, in manufacturing one ton of peat fuel containing 25 per cent of moisture from raw peat containing 87½ per cent of water, the decrease in the quantity of water which has to be evaporated is 13,500 less 10,500, or 3,000 pounds, a quantity amounting to over 22 per cent of the total quantity of water in the peat containing 90 per cent of water. In other words, a reduction of only 2½ per cent in the water content of the raw peat means a decrease of over 22 per cent in the water which must be removed to obtain one ton of air-dried peat with 25 per cent of moisture. Reducing the moisture content of the bog by complete draining would therefore materially shorten the time required to dry the manufactured material to 25 per cent moisture, and would consequently make possible a larger production during the comparatively short working season. The capacity of the machine per hour would be increased by 25 per cent and a larger quantity of peat could be spread on the field because of the shorter drying period required.

Peat made in this manner is a clean fuel to handle, and produces little soot or other deposits when burned in an ordinary stove or fire place. The ash accumulates in a very finely divided state free from combustible matter, and can be easily removed. When burned for domestic purposes clinkers are not formed and on account of the ease with which the fuel ignites often only a little paper or a few shavings are sufficient to start the fire.

Peat fuel on the other hand is more bulky than coal and is of course of lower heating value per pound. The relation between anthracite coal and peat fuel as regards theoretical heating value is approximately 12,500 to 6,000 or 2 to 1. This is

assuming that the peat having a heating value of 9,200 B. t. u's. per pound when absolutely dry is used with a moisture content of 30 per cent. Allowance is therefore made for the heat required to raise the contained moisture to 212° F. and evaporate it and also the heat required to superheat the steam when the peat is burned in a boiler or gas producer. For a definite quantity of heat, therefore, it will be necessary to store twice the weight of the coal required in peat fuel. The volume occupied by the peat fuel owing to its low specific gravity will also be much larger than that of coal. One cubic foot of ordinary anthracite coal weighs approximately 56 pounds, while one cubic foot of machine peat weighs approximately 27 pounds. The volume of peat required to equal coal of the above heating value will therefore be roughly four times that of coal. This is a matter of considerable moment and introduces serious problems when large quantities of fuel must be stored.

If it is desired to manufacture peat fuel on a large scale for transportation over long distances by rail it would seem imperative that an effort be made to reduce the bulk of the fuel by increasing its density. This, of course, can be accomplished by briquetting, but before any attempts can be made to reduce peat briquettes economically, the raw peat will first have to undergo the treatment just described. After the water content has been reduced by air drying to some 50 per cent it may be economically possible to further reduce the moisture to say 15 per cent by artificial drying. The peat blocks as they are brought in from the field, however, first would have to be ground. The dried fuel could then be briquetted with a suitable binder or used in the form of powder for various purposes.

Action of Frost on Partially Dried Peat

Care must be exercised in the manufacture of peat fuel to discontinue manufacturing operations in time to permit the fuel to dry below 50 per cent moisture at least, before severe frost sets in, since, if any of the peat which is manufactured has not had sufficient time to dry to 50 per cent before this time it will be frozen and the peat will disintegrate into a fine dust which is useless as a fuel for many purposes. If it is found that peat containing the above moisture content cannot be dried before the

cold weather sets in it should be harvested and placed under cover or piled in stacks.

Permissible Moisture Content of Peat

For Domestic Purposes.—It is customary to reduce the moisture content to between 25 and 30 per cent, but it is even desirable to have a slightly higher moisture content, inasmuch as the drier peat burns too quickly and with the ordinary stoves used on this continent it is difficult to control the combustion. Peat fuel containing 30 per cent of moisture is also tougher and therefore stands handling better than the drier fuel. In Sweden stoves are especially designed and constructed for burning peat fuel; hence, peat with 25 per cent or less of moisture can be used to advantage.

For the Generation of Steam.—The moisture content of the fuel should not be in excess of 30 per cent, preferably 25 per cent, to obtain the best results. With increase of moisture the results due to the heat escaping with the superheated steam becomes considerable.

For Use in the Gas Producer.—The moisture content should be kept as low as 35 per cent. Fuels with a higher moisture content have been used in both the by-product recovery producer of the Mond type and gas producers without by-product recovery, but for producer work the best results are obtained with peat having a water content of 35 per cent and less.

For the Manufacture of Peat Powder as Conducted in Sweden.—It is usual to permit the peat blocks on the field to dry to 50 per cent moisture. When this degree of dryness is reached the peat is harvested and transported to the factory, where it is crushed, ground, and put through a drier. The driers used for this purpose are especially designed and employ a high temperature, the object being to submit the particles of peat to a sufficiently high temperature to cause the paraffins to sweat out. This forms a coating over the particles and makes them waterproof. For peat powder the moisture content should not exceed 13 per cent.

For the Manufacture of Briquettes—It is usual to dry the peat by artificial means to 15 per cent or lower.

Extravagant claims have been made that peat with a high moisture content can be economically used for the generation of power in steam boilers and gas producers. It has been stated that peat containing between 60 and 70 per cent of water can be successfully burned in the by-product recovery producer of the Mond type. It may be of interest to introduce here the heat balance which was calculated to show the impossibility of generating a power gas in the Mond by-product recovery gas producer with peat fuel containing 60 per cent of moisture. This heat balance, taken from the writer's report "Peat, Lignite, and Coal," was based on the following assumptions:

1. The peat substance is completely gasified.
2. The water in the peat is distilled off with the gas undecomposed.
3. All air enters the producer saturated at 60° C.
4. The steam introduced with the air is decomposed.

Heat Balance

ENTERING THE PRODUCER

1. Potential heat units of wet peat fired equals gross calorific power of wet peat.
2. Sensible heat (above 0° C.) viz. air plus water at 60° C.
3. Latent heat of steam at 60° C.

LEAVING THE PRODUCER

4. Potential heat units in gas generated equals gross calorific value of gas.
5. Sensible heat of gases, including the steam, at 200° C. reckoned from 0° C.
6. Latent heat of steam in gases at 0° C.
7. Radiation losses.

Values Used in Calculation

H = 1 C = 12 N = 14 O = 16

1 gram molecule occupies 22.4 litres at 0° C. and 760 mm.

Latent heat of steam at t° C. = 606.5 — 0.695t calories (Regnault).

MEAN SPECIFIC HEATS AT CONSTANT PRESSURE

Air,	0° —	60° C. = 0.237	Regnault.
N_2,	0° —	200° C. = 0.244	"
CH_4,	0° —	200° C. = 0.593	"
H_2,	0° —	200° C. = 3.409	"
CO_2,	0° —	200° C. = 0.217	"
CO,	0° —	200° C. = 0.245	"
Steam,	0° —	200° C. = 0.453	Pier.

Gross Calorific Powers in Calories Per Gram Molecule

$CO = 68.200$
$CH_4 = 213,500$
$H_2 = 69.000$

Analysis of Peat Burned

	Dry.	Sixty per cent moisture.
Carbon	56.0	22.40
Hydrogen	5.2	2.08
Nitrogen	1.9	0.76
Oxygen	30.9	12.36
Ash	6.0	2.40
Water	0.0	60.00

Calorific Power

	Dry.	Sixty per cent moisture.
Calories per gram	2,102.2	.....
B. t. u's. per pound	9.460	3,784.0

One hundred grams of peat containing 60 per cent of H_2O, 86.0 grams of air, and 13.4 grams of H_2O, can give in the producer, 2.40 grams of ash, 60 grams of steam, together with 66.82 grams $N_2 + 2.72$ grams $CH_4 + 2.89$ grams $H_2 + 46.93$ grams $CO_2 + 17.64$ CO.

The permanent gases are:

2.386 gram mols. $N_2 + 0.170$ gram mols. $CH_4 + 1.445$ gram mols. $H_2 + 1.067$ gram mols. $CO_2 + 0.630$ gram mols. CO. Total 5.698 gram mols. or 127.6 litres.

This gas has the following composition:

N_2	41.88
CH_4	2.98
H_2	25.36
CO_2	18.72
CO	11.06

Calorific power in B. t. u's. per cubic foot moist at 60° F. and 30″ Hg.

Gross	147
Net	131

The air in order to carry with it the above proportion of steam must have been saturated at a temperature of about 60° C.

Heat Balance

	(Calories)		(Calories)
(1)	= 210,220	(4)	= 178,950
(2)	= 2,027	(5)	= 13,890
(3)	= 7,570	(6)	= 36,390
		(7)	= 9,410
	219,820		219,820

It will be observed from the above calculation that under the most ideal conditions—which do not and cannot obtain in actual practice—the quantity of heat generated by the burning of peat containing 60 per cent moisture in a producer is not sufficient to effect the various reactions and provide for losses. It is more within the realm of probability that complete combustion would have to take place in order to permit the production of the necessary quantity of heat.

Briquetting of Peat Fuel

As stated above, when it is desired to transport peat fuel any considerable distance by rail or by water, and when the question of storing a large quantity of this fuel becomes an important factor, it will be necessary to consider ways and means of reducing its volume so that the heat units per cubic foot will be increased sufficiently to enable it to compete with coal on a more equal basis. This reduction in volume can only be realized by briquetting; but briquetting involves the evaporation of the moisture content of the peat from the air-dried percentage to 15 per cent, the maximum permissible. It has been previously pointed out that in order to obtain a large production of air dried machine peat it might be necessary to attempt to dry in the field to only 50 per cent. In this case the quantity of 50 per cent moisture peat which would be required for the manufacture of one short ton of briquettes containing 15 per cent of moisture would be as follows:

2,000 pounds of 15 per cent moisture peat contains:

	(Pounds)
Absolutely dry peat	1,700
Water	300

2,00 pounds of 50 per cent moisture peat contains:

	(Pounds)
Absolutely dry peat	1,000
Water	1,000

Therefore 1.7 tons of 50 per cent moisture peat will be required to produce 2,000 pounds of 15 per cent moisture peat. The water which must be removed to reduce 1.7 tons of 50 per cent moisture peat to 15 per cent will be 1,700 less 300 or 1,400 pounds, and this would involve the expenditure of $1,400 \times 1,120 \times {}^{100}/_{70}$, or 2,240,000 B. t. u's. (assuming that the heat requred to raise 1 pound of water from 60° to 212° F. and evaporate it is 1,120 B. t. u's. and that the dryer efficiency is 70 per cent). If the heat for this evaporation is to be furnished by burning 50 per cent moisture peat fuel, the quantity of fuel which must be burned is as follows: Assuming the heating value of absolutely dry peat to be 9,200 B. t. u's. per pound, 1 pound of peat containing 50 per cent of moisture will have a gross heating value of 4,600 B. t. u's. The heat required to evaporate ½ pound of water will be $\frac{1}{2} \times 1,120$, or 560 B. t. u's. and 4,600 — 560, or 4,040 B. t. u's. will then be the effective heating value of the fuel. To furnish the above quantity of heat, namely, 2,240,000 heat units, 554 pounds of 50 per cent moisture peat fuel will be required. Therefore the quantity of 50 per cent peat which would be required to produce one ton of briquettes containing 15 per cent of moisture, exclusive of the fuel required to supply other quantities of heat required in the process, is about 2 tons.

Whether this would be economic or not depends on the cost at which 50 per cent moisture peat can be laid down on the field and transported to the plant for briquetting, and upon the feasibility of supplying a sufficiently large tonnage to the briquetting plant to enable overhead charges to be reduced to the lowest possible cost per ton.

Peat can be briquetted with the addition of a suitable binder both in the raw state and carbonized. In each case the reduction in volume is very appreciable, especially in a carbonized briquette, and in addition to being waterproof the briquettes can stand rough handling and can be burned without disintegrating in the fire. At the termination of the work of the Peat Committee it is hoped sufficient data will be available to enable a statement to be made concerning the feasibility of briquetting air-dried machine or carbonized peat.

Carbonizing of Peat

Many attempts have been made to carbonize peat, notably in Germany and Russia, and, of course, in England. In England much work has been done and a large amount of money expended in efforts to produce a fuel by wet carbonizing. In Germany and Russia, however, the attempts which were made to carbonize peat were confined to the manufacture of a metallurgical coke and to the recovery of certain valuable by-products. The coking plants which showed the greatest promise of commercial success were those designed by Zeigler, but while they were reported to be operating on a commercial basis and with a profit, they were closed prior to the war. At that time, when coal was plentiful and could be obtained at very low prices, it was difficult, if not impossible, for a low grade fuel like peat to compete with coal for such purposes as the manufacture of coke, especially since the value of the by-products derived from peat were not at that time appreciated to as great an extent as they are today. What was a commercial failure then, however, might today be a success.

In the manufacture of peat coke, as conducted in Germany, the peat used had the following components:

Carbon	35.3
Hydrogen	3.4
Nitrogen	0.7
Sulphur	0.1
Oxygen	28.4
Ash	0.9
Moisture	31.0
Calorific value, (B. t. u's. per pound)	6,161

It yielded the following products:

	(Tons)
Peat coke	163.7
Tar	25.8
Tar water	269.0
Gases	330.0
Loss	0.3

The 25.8 tons of tar yielded the following products on distillation:

	(Tons)
Light oils	11.6
Heavy oils	3.9
Paraffin	1.8
Phenol	7.6
Asphalt	0.8

This is equivalent to 4.5 per cent of the weight of the peat coke.

The 269 tons of tar water yielded on further distillation:

	(Tons)
Methyl alcohol	1.8
Ammonia	0.9
Acetic acid	2.5

The maximum heating value of the gas produced was 322 B. t. u's. per cubic foot, and the temperature at which retorting took place was about 600° C. The peat coke was of a most excellent chcaracter and well suited for metallurgical purposes, but its cost per ton was said to be so high that it could not compete with the metallurgical coke made from coal. It will be of interest to include here the results obtained in our laboratories in carbonizing peat.

PRODUCTS OBTAINED BY SOLW HEATING TO 650° C

	Percent of Dry Peat Treated
Coke	41.4
Tar	12.0
Gas	26.8
Water	19.4
Loss	0.4

HEAT UNITS IN PER CENT OF DRY FEAT

Coke	54.7
Tar	20.7
Gas	10.8
Loss	13.8

CHARACTER OF PEAT TAR OIL

Density of heavy oils	1.029
Density of light oils	0.939
Density of total oils	1.005
Calorific value (B. t. u's. per pound)	15,150

DISTILLATION YIELDS PERCENTAGE BY WEIGHT OF TAR

Up to 170° C.	1.7
" 170°-200°	6.4
" 200°-270°	25.9
" 270°-310°	25.2
Residue	32.5
Water	3.3
Loss	5.0

Gas from Peat

CO_2	43.7
C_2H_4	1.2
O_2	1.7
CO	12.4
CH_4	18.0
H_2	17.7
N_2	4.3
Density	0.98
Calorific value, gross	314.00
Calorific value, net	282.00

Commercial Products

Coke, pounds per ton of dry peat	830
Calorific value, B. t. u's. per pound	12,800
Tar, imperial gallons per ton of dry peat	24
Gas, cubic feet per ton of dry peat	6,600
Calorific value of gas, B. t. u's. gross per cuic foot	314
Ammonium sulphate, pounds per ton of dry peat	25

Utilization of Peat for the Generation of Power and Industrial Gas

Peat has been and is today being successfully utilized for the production of power:

1. By burning it in especially designed boilers for the generation of steam.
2. By burning in by-product recovery producers of the Mond type.
3. In gas producers without by-product recovery.
4. For burning in locomotives.

The most notable steam power plant utilizing peat exclusively as a fuel is that erected by the Siemens Electric Co. on the Wiesmoor in Germany. This steam plant is of most modern design, consisting of specially designed steam generators, Zoelly steam turbines, and elaborate and well worked out conveying machinery for transporting peat from the sheds to the boilers. The fuel is fed to the boilers automatically, and it was claimed that very high boiler efficiencies were obtained, namely, in the vicinity of 73.5 per cent. In dry weather a consumption

of 2.4 kilograms (5.28 pounds) per k. w. hour has been obtained; in wet weather, however, the fuel consumption is 3 kilograms (6.6 pounds) and upwards per k. w. hour. The capacity of this power plant was in the neighborhood of 5,400 H. P. when the writer visited it. It was said that with peat fuel containing 30 per cent of moisture and costing $1.25 per ton delivered to the plant, power could be more cheaply produced than with coal costing $3.50 per ton delivered to the plant.

Peat fuel in the form of powder is employed for generating steam on the locomotives of the Swedish State Railways. Three by-product recovery gas producer plants of the Mond type have been erected for utilizing peat fuel for the generation of a power gas. Two of these plants are situated in Italy, one at Orentano and the other Codigoro. The third plant in Germany was reported some time ago to be closed.

Peat containing a high percentage of nitrogen is an exceedingly valuable fuel for burning in the by-product recovery producer, inasmuch as the sulphate of amonia recovered as a by-product would in certain cases pay the entire cost of operating the plant, thus permitting the power gas, or power when generated, to be sold at a very low cost. There are several bogs in Canada and a number in the United States which are especially suitable for the installation of such a plant.

Unless peat fuel can be obtained at an exceedingly low cost, it cannot be considered, except in isolated cases, as a suitable fuel for the generation of power when burned in a gas producer of the non-byproduct recovery type.

Peat Resources of Certain Countries

Before concluding this paper the writer would like to make a few remarks concerning the peat resources of certain of the civilized countries of the world. The United States, exclusive of Alaska, according to C. A. Davis, late peat expert of the United States Bureau of Mines, possesses 139,855 square miles of swamp lands, 8 per cent, or 11,188 square miles of which it is estimated contains peat deposits of good quality. Assuming that the average depth of the peat in this area is at least nine feet and that the average yield will be 200 tons of saleable fuel per acre

foot, the total available fuel in these deposits will reach 12,888,500,000 tons.

Canada has an area estimated at 37,000 square miles covered by peat, a large portion of which is suitable for the manufacture of peat fuel. Twelve thousand square miles of this area is situated in the more inhabited portions of the Dominion, and if it is assumed that this 12,000 square miles is all suitable for the manufacture of a fuel and has an average depth of 6 feet, there will be sufficient peat to manufacture over 9,000,000,000 tons of 25 per cent moisture peat.

Ireland alone has 3,000,000 acres of peat bogs having an average depth of 26 feet, capable of producing over 5,000,000,000 tons of peat fuel. The heating value of the Irish peat, absolutely dry, is about 10,000 B. t. u's. per pound. Other parts of Europe also possess enormous areas of peat bogs.

From the above it will be seen that the heat energy lying dormant in the peat areas of the world may in a short time become a very important factor in maintaining our civilization, and while in certain countries the necessity for utilizing this source of fuel may not be immediate, efforts should be made to gain all the requisite knowledge and data which it is necessary to have before peat bogs can be exploited, so that when the peat era does arrive no time need be lost in the development of the bogs.

NEWS OF THE DOMESTIC INDUSTRY.

Georgia.

SCIENTISTS URGE PRESERVATION OF OKEFENOKEE SWAMP.

That the preservation of the Okefenokee swamp in its primitive condition would be of greater value to science than the drained land to agriculture is the contention of the Society of Scientists recently organized to combat the possibility of a movement to reclaim this famous swamp for farming or other commercial uses. Several years ago the State legislature considered a bill introduced for the purpose of setting aside the famous swamp, which covers 500,000 acres. Professor James G. Needham, of Cornell University, president of the society, which comprises many of the nation's foremost scientists, confidently expects the bill to be passed by the next legislature.

The chief value of the swamp to science lies in the great variety of plants and the profusion of animal life in its dense recesses. Great quaking peat bogs abound in the area and it is said that the varieties of birds, insects, and crustaceans are unequaled in any region of similar size. According to Dr. J. F. Wilson, editor of the Nut Grower, bear, deer, and panthers are also found in the swamp.

Minnesota.

PEAT FUEL PROJECT MAKES GOOD PROGRESS

It is reported that the $200,000 peat pulverizing plant of the Hennepin Atomized Fuel Co., of Minneapolis, Minn, was opened in January. The plant is located one block from Broadway on Johnson Street, N. E. At a recent meeting of the directors of the company the capitalization was increased from $550,000 to $750,000 and the following officers were elected for the year 1921: F. E. Bryan, president; G. H. Reeves, vice president; and John Pears, secretary-treasurer.

According to reports peat produced at a cost of from $4.00 to $5.00 per ton by this company from a deposit near Superior boulevard within a few miles of Minneapolis is being used to heat one of the large office buildings of that city. The secretary-treasurer of the company states that 106 pounds of pulverized

peat are capable of generating the same heat as 96 pounds of powdered coal.

Wisconsin

Superior Shows Much Interest in Peat

Much interest has recently been shown by the citizens of Superior, Wis., in the possibilities of utilizing the local peat deposits for fuel. C. C. Osbon, of the American Peat Society, who was formerly in charge of peat work for the United States Geological Survey, was invited to address meetings of the Civic and Commerce Association and Rotary Club of Superior on December 7 and 8. Several hundred citizens listened to his statements and it is believed that the interest stimulated will result in some tangible results this spring. The National Peat Products Co., of Minneapolis, which has a branch office at Superior, is making an energetic attempt to arouse interest in peat fuel in Wisconsin.

NEWS OF THE INDUSTRY IN FOREIGN COUNTRIES

Bolivia

Important Peat Deposit Near La Paz

Lying about 10 miles east of La Paz on the La Paz-Yungas Railway are found large peat fields or beds which cover an area of about 2,500 acres, with a depth of peat varying from 16 to 24 feet. The possible value of these beds was not realized until about two years ago when they were taken up by an engineer in the employ of the Bolivian Government. It is estimated that there are in these fields 150,000,000 cubic metres of peat, which would yield 30,000,000 tons of dried peat briquettes. This peat is said to have a fuel value equal to one half that of coal and a little greater than that of hardwood.

Present Development Limited

The fields are being worked only in a very small way as the owner lacks sufficient capital to develop them properly. At present only about 50 men and women are employed, and two small machines used. A large part of the output at the present time is what is known as handmade blocks; that is, the natural peat cut into blocks and allowed to dry without any machine process. The machine-made blocks are made by grinding the peat very much as brick clay is ground. No pressure is used or needed in molding the blocks as the pulp resulting from the ground peat dries in a very compact form and is nearly as hard as coal.

Scarcity of Fuel in Western Bolivia

It is estimated that La Paz alone consumes 40,000 tons of fuel annually. All kinds are very scarce and expensive; coal costs about $100 per ton, wood $1 per 100 pounds, and they are both difficult to obtain even at these prices. The principal fuel, taquia or llama manure, sells at 2 bolivianos per 100 pounds, and during the wet season is very difficult to obtain. Taquia is the fuel most used for domestic purposes, such as cooking; houses are not heated. The mining industry and industrial plants also use

a great deal of this fuel. Because of the scarcity of fuel and its high cost, there is a good market in La Paz and all of western Bolivia for any moderate-priced and satisfactory fuel such as peat blocks, which have the advantages of being clean, easily handled, and obtainable at all times in large quantities.

Prospects for Development of Industry

Near the peat fields is a waterfall estimated to be capable of developing from 100 to 150 horsepower. It is proposed to utilize this power for the operation of machinery and possibly for the operation of an aerial cableway to La Paz, as it is believed that it would be cheaper to have such a cableway than to be dependent upon the railway for hauling the product to La Paz. It is also proposed to dry the blocks at the fields, so that they will not be injured by freezing, or to send the wet peat as it is taken from the beds to a yard near La Paz, where freezing weather is unusual, to be made into blocks and dried in the open air.

The owner of the fields has recently ordered machinery from Sweden for making peat briquettes, with a capacity of 50 tons per day. One of the railways is to soon give the briquettes (mixed with an equal quantity of coal) a trial in its locomotives.

It is estimated that $250,000 is the capital necessary to develop these fields properly. Bolivia is seriously handicapped by lack of fuel, and the development of this very large and easily available supply of fuel would be of great benefit to the whole country.—*Commerce Reports,* October 27, 1920.

Germany

Gas Production Successful

It is reported that gas is being successfully manufactured from peat at Norden in northwestern Germany. The municipal plant is said to be making a gas 30 per cent of which comes from peat and the remainder from coal. The resulting gas has the same illuminating properties as pure coal gas and thus far no disadvantage has developed. According to reports the municipal authorities are well satisfied with the outcome of the experiment. The region adjoining Norden contains much peat and

it is believed that the experiment will lower the price of gas and stimulate the local peat industry.—*Washington, D. C., Herald,* December 29, 1920.

Latvia.

Outlook for Peat Coke Production.

Baltic Provinces of the former Russian Empire have imported coke to a considerable extent. The imports for 1910, 1911, 1912, and 1913, were 2,500,000, 4,200,000, 5,000,000, and 6,000,0 poods (pood = 36.13 pounds), respectively. Ninety per cent of this coke came through the port of Riga.

At the present time there is under way a plan to make use of the peat in the moorlands of Estonia and Latvia, owing to the prevailing high prices and the consequent almost prohibitive cost of imported coke. Enormous quantities of peat may be furnished from these bogs as they have an area of 1,900 square miles in Esthonia and 2,400 square miles in Latvia.

According to estimates, the coke from this source will be about five times as cheap as imported coke, and in addition there will be a yield of by-products, consisting of tar, photogen, lubricating oils, paraffin, asphalt, and gas. Experiments are being carried on by the Board of Amelioration of Latvia. These projects open bright prospects for the revival of industrial activities in the Baltic Provinces.—*Commerce Reports,* November 6, 1920.

Poland

Peat Extensively Used for Fuel

Wood and peat are both extensively used for fuel at Danzig, particularly by individual consumers. Considerable quantities have been cut in the vicinity of the city, often at the expense of scenic beauty. Every bit of available firewood is utilized, great pains being taken in the extraction of stumps.

Peat is found in Pommerellen, East Prussia, and to a less extent in the Free City territory. The peat-drying industry, principally for home consumption, commenced on a small scale during the last two years of the war, and has now become of considerable importance. Reports vary as to the quality of the peat.

The dry, sunny weather of the first half of the summer was very favorable for the peat industry. —*Commerce Reports,* October 25, 1920.

TRUCK GROWING ON MUCK IN THE KANKAKEE MARSH OF NORTHERN INDIANA[1]

By J. H. Beattie
United States Department of Agriculture

It is not necessary to take the time of the American Peat Society to call attention to the vast muck and peat resources of the country and to their possible application for agricultural and manufacturing purposes. We are all more or less familiar with the magnitude of the problem, but it is hard for any of us to grasp the fact that there are over 126,000 square miles, or more than 80,000,000 acres of swamp lands in the United States east of the one-hundredth meridian, and that a considerable portion of this area is muck and peat. The economic value of these deposits is hard to estimate, but it is safe to say that, where reclaimed and put to the uses for which such soils are adapted, they constitute an exceedingly valuable economic asset. It is my desire to call to your attention in a very brief way some factors bearing on this great problem from the viewpoint of truck crop production, the phase of the subject in which the Office of Horticultural and Pomological Investigations of my department is especially interested. It should be noted at the outset that a comparatively small percentage of the muck soil areas in Wisconsin, Minnesota, Michigan, Indiana, and Ohio will grow all the truck crops that can for a long time be consumed by markets within shipping distances of these areas. It is our feeling, however, that these soils have great possibilities for the production of crops that can be preserved by canning and drying, and if these possibilities develop into actualities it is hard to conceive of the limitations of mucks for the production of vegetable crops.

One cannot spend much time in studying the problem of peats and mucks and their adaptibility to truck crop production without being soon convinced that our knowledge of the problem is limited. Much research work must be done before we can say with reasonable assurance that we have mastered even the fundamental principles of the problem. Certainly we know that

[1]Delivered at the Forteenth Annual Convention of the American Peat Society, Madison, Wis., September 3, 1920.

we can grow such crops as onions, cabbage, celery, and lettuce on muck soils, and we can say, with reasonable assurance, that most muck soils are deficient in either potash or phosphoric acid or both, but the fact remains that the problem of handling muck, the working out of suitable crop rotations, and the development of strains and varieties suited for growth on these soils are yet largely to be mastered.

Plan of the Work

Let me call your attention first to some work inaugurated several years ago in the Office of Horticultural and Pomolagical Investigations by Professor H. C. Thompson, formerly president of this society. The American Peat Society took an active part in the work, though I believe that the results have never been summarized and presented to the society. I refer to the work carried on at North Liberty, Ind., on the great Kankakee Marsh, which had as its object the study of fertilizer mixtures and the development of strains of onions, celery, and cabbage adapted to the conditions found in that general section

As originally planned, the work was to have been conducted in several different locations, as it was felt by those inaugurating the study that by making regional tests of the different muck and peat deposits in the various geographical sections of the country, it might be possible to recommend intelligent suggestions as to the best treatment for these soils. It has been the fixed plan of the department to continue the work outlined several years ago, as all the evidence accumulated indicates that the character of the vegetation from which the various deposits originated bears a marked influence on their value from an agricultural viewpoint, and that fertilizer and management studies conducted in several locations on representative deposits will throw considerable light on the value of these soils for the production of truck crops

As originally outlined the work was carried on in two different locations—Great Meadows, N. J., and North Liberty, Ind. The work at Great Meadows was continued for several seasons and the work at North Liberty, started in 1915, was continued for three seasons, or until interrupted by the war. Within the past two years it has been possible to actively resume field work

on the adaption of truck crops to organic soils. Owing to changed conditions at both Great Meadows and North Liberty, it appeared desirable to renew the work in new locations. The funds available permitted the resumption of the work in two locations, one in western New York in cooperation with the New York State College of Agriculture, in charge of Professor Thompson of that institution, and the other near South Bend in northern Indiana. It seemed desirable to renew the work at or near the old location in Indiana so as to take advantage of the results gained in the North Liberty work. It was felt that the extensive Kankakee Marsh, located near some of the large markets, was well worthy of further study. An almost ideal location was found on the farm of A. C. Steenburg & Son, about eight miles southwest of South Bend and about five miles from the old area at North Liberty, containing the same type of muck. A discussion of the scope and nature of the new work will be given after a brief review of the results obtained during the three seasons work at North Liberty.

The North Liberty experiment was laid out to include three crops—onions, celery, and cabbage. The rotation adopted called for onions the first year, celery the second, and cabbage the third year. This, of course, meant that each year one set of plats was in onions, one in celery, and one in cabbage. The fertilizer, manure, and lime treatments, gave practically all combinations that would be met in every day practice. The nitrogen, lime, and manure applications were constant across each row of plats, and the phosphate and potash salts in varying amounts ran the long way of the plats. It was found that this outline was open to the objection that it had too few checks or controls, and is a little too complicated for a practical field experiment. It was our feeling that even experimental work of this class should be made as nearly comparable as possible to actual field conditions. This experiment was subject to more than its share of vicissitudes in the form of several changes in the personnel of the men in charge of the field work and other causes. In spite of all the difficulties experienced some interesting results were secured, and instead of indulging in a detailed study of the experimental data secured, it is felt that it will be sufficient at this time to call attention to some outstanding deductions drawn

from a study of the weights of the crops grown on the plats. Each set consisted of 72 plats one and one half by two rods in size and containing three square rods. It is believed that a plat of this size is sufficiently large to minimize the error due to the movement of fertilizer from one plat to another through wind, leaching, and the action of tillage tools. To minimize the error the experiment was laid out with four foot paths between the plats. It is felt, therefore, that the conclusions arrived at, while not necessarily final in themselves, are strong indications of the real truth. It should have been noted earlier in these remarks that the area selected for the work had no special treatment during the five years it was previously used. It had received several applications of an ordinary commercial fertilizer, but had received no lime or other special dressing.

Results of Onion Culture

Th following table summarizes the results secured with the onion fertilizer tests in 1915 and 1916. No attempt will be made at this time to make a detailed study of the effect of all the fertilizer mixtures, as this would consume too much time. The table indicates a few of the more striking lessons.

Summary of Onion Fertilizer Tests at North Liberty, Ind., 1915-1917

Kind of Fertilizer.	Quantity (pounds per acre).	Yield (pounds per acre).
None	....	356.7
$NA\,NO_3$	200	220.8
Tankage	200	
Acid Phosphate	457	365.3
KCl	200	467.9
KCl	400	449.9
K_2SO_4	200	426.2
Manure	30,000	490.7
Limestone	2,000	377.4

SUMMARY OF ONION FERTILIZER TESTS AT NORTH LIBERTY, IND.. 1915-1916
(Continued)

Acid Phosphate	457	470.2
KCl	200	
Acid Phosphate	457	477.9
KCl	400	

The negative results secured by the application of nitrate of soda and tankage can be explained to a certain extent by the fact that these plats were located along the edge of the experimental area and for this reason suffered severely, especially during 1916, from a severe windstorm. For this reason too much dependence should not be placed upon these figures. The highly significant thing, however, is the marked increase in yield from the use of 200 pounds of muriate of potash per acre. This 200 pounds of potash salt gave an increase per acre of about 111 bushels. Applications of the same salt at the rate of 400 pounds per acre gave a smaller increase than was obtained from the application of 200 pounds. This decrease was consistent on all plats receiving the increased amount of muriate of potash, and the indications are that the larger amount was an excessive application for this particular soil. Attention is also directed to the lack of response to acid phosphate and limestone, and to the marked response from stable manure, the increase in this case being far beyond that to be expected from the amount of the various fertilizing elements in the manure.

RESULTS OF CABBAGE CULTURE

Very satisfactory results, as shown in the following table, were secured in the cabbage experiments. Weather conditions during all three seasons while this work was in progress were very favorable.

SUMMARY OF CABBAGE FERTILIZER TESTS AT NORTH LIBERTY, IND., 1915-1917

Kind of Fertilizer.	Quantity (pounds per acre).	Yield (pounds per acre).
None	200	21,531.4

SUMMARY OF CABBAGE FERTILIZER TESTS AT NORTH LIBERTY, IND., 1915-1916
[Continued]

Kind of Fertilizer.	Quantity (pounds per acre).	Yield (bushels per acre).
$NaNO_3$	200	22,711.1
Tankage	200	
Acid Phosphate	457	20,939.0
KCl	200	35,281.0
KCl	400	42,330.0
K_2SO_4	200	32,585.6
Manure	30,000	37,770.1
Limestone	2,000	24,842.8
KCl	200	37,377.5
Acid Phosphate	457	
KCl	400	42,457.2
Acid Phosphate	457	
$NaNO_3$	200	38,792.4
Tankage	200	
KCl	400	
KCl	400	43,846.0
Manure	30,000	
Limestone	2,000	41,772.7
Manure	30,000	

The same general results were secured as in the case of the other crops. Small applications of muriate of potash gave large increases, but the cabbage was able to utilize even larger amounts of the potash salt, as shown by the increase in yield between the application of 200 and of 400 pounds per acre. It is also noticeable that the sulphate of potash gave poorer results than did an equal application of muriate, and as in the case of onions and celery, acid phosphate gave a slightly negative result.

Limestone gave an increase so small that its application would not be commercially profitable.

Results of Celery Culture

The result of two seasons of work on celery is summarized in the following table:

Summary of Celery Fertilizer Tests at North Liberty, Ind. 1915-1916

Kind of Fertilizer.	Quantity (pounds per acre).	Yield (pounds per acre).
Acid Phosphate	457	14,430.5
KCl	200	19,880.9
KCl	400	24,704.1
K_2SO_4	200	17,882.2
$NaNO_3$	200	19,161.2
Tankage	200	
None	....	11,992.5
Manure	30,000	22,785.7
Limestone	2,000	13,644.6
KCl	200	24,186.3
Acid Phosphate	457	
KCl	400	27,562.5
Acid Phosphate	457	
$NaNO_3$	200	20,440.6
Tankage	200	
KCl	400	
KCl	400	26,869.6
Manure	30,000	
Manure	30,000	24,027.7
Limestone	2,000	

Attention is called to the general similarity of the results

with those secured in growing onions and cabbage. Application of nitrate of soda and tankage at the rate of 200 pounds each per acre, a total of 400 pounds per acre, gave a marked increase over the check, the yield per acre from the check being 11,992 pounds, and from the application of nitrogen 19,161 pounds. It should be noted, however, that the celery from the plats receiving the nitrogen was pithy and of poor quality. The response of the celery to potash salts, acid phosphate, and manure was very similar to the results secured with the other crops. Likewise applications of limestone gave but slight increases over the check.

Conclusions

From this brief study of the action of fertilizing elements on the muck soil at North Liberty, Ind., in the growing of onions, cabbage, and celery, it is evident that applications of nitrate of soda, tankage, acid phosphate, and lime had very little effect, and that applications of the potash salts, particularly muriate and manure, gave marked increases.

In the work now being conducted at Steenburg, Ind., many changes have been made in the plans, but none of these have been brought about by any feeling on our part that the original outline was essentially incorrect. We have tried to take advantage of some of the lessons learned in the former work; first, that to prevent damage by wind it is necessary to adopt a practical truck crop rotation that will keep plenty of organic matter in the soil; and second, that protection to the crops must be given. The latter experiment has been laid out on the unit basis—each unit of nitrogen, phosphoric acid, or potash meaning so many pounds per acre—thus greatly simplifying the experiment over the one at North Liberty.

Active field work was started on the experiment of Steenburg early in 1920, and a five year rotation calling for onions, cabbage, celery, lettuce, and sod in the order named will be followed. Advantage will be taken of every opportunity to grow green crops, either between the rows of the truck crops, or after these crops have been removed. This work, as indicated previously, is being carried on in duplicate in two different locations, and it is our hope that at some future time, we will have the pleasure of presenting the results to this society.

EXPERIMENTAL WORK ON MINNESOTA PEAT SOILS[1]

By F. J. Alway,
University of Minnesota

Minnesota has about 7,000,000 acres of peat soils. These belong chiefly to the high-lime group, although low-lime peats occur on many bogs in the northeastern and central counties. Our low-lime peats are less extensive and usually less accessible to present railways and settlements as well as far more expensive to reclaim.

FIRST APPROPRIATION

The legislature of 1917 made an appropriation of $6,000 a year for three peat experimental tracts, including drainage, buildings, fencing, seed, fertilizers, labor, and traveling expenses. The sites that have been selected are situated like the angles of a right-angled triangle with sides of 150, 200, and 250 miles, the southern at Coon Creek, just north of Minneapolis, the second at Fens in the forest 150 miles to the north, and the third at Golden Valley on the edge of the open prairie 250 miles to the northwest. The surface soil at all three places is a poorly decomposed high-lime peat with no unusually high content of phosphoric acid or potash.

THE GOLDEN VALLEY TRACT

On the Golden Valley tract the thickness of the peat layer varies from 10 inches to more than 3 feet. If the peat blanket were stripped off, the exposed soil would look like a good black prairie silt-loam with a loam or clay loam subsoil—really part of a till plain. A large open ditch runs beside it, cutting far below the bottom of the peat. The only obstacle to the plow is met in the form of an occasional boulder in the underlying till where the peat is shallowest.

The farmers of that district devote themselves chiefly to the growing of grain, but produce more or less stock and dairy

[1]Delivered at the Fourtheenth Annual Convention of the American Peat Society, Madison, Wis., September 2, 1920.

products. They wish to use their peat lands the same as their mineral soils—for grain and tame hay or as improved pastures. They early found the peat was easily prepared for the drill but that it yielded crops too light to be worth harvesting. One of the most progressive farmers adopted the practice of burning the peat on the surface as the result of an observation that a crop made far better growth on a part of a field that had been accidentally burned. His neighbors had begun to follow this example at the time we were seeking a location in a northwestern county.

Part of a field that was still burning and an adjacent unburned area were included in the lease of the Golden Valley tract. On the latter the ordinary fertilizer applications were made, except that nitrogen and lime were omitted. Grain, grass, clover, and root crops were tried with different treatments, viz., no application, potash only, acid phosphate only, potash with phosphate, stable manure, manure reinforced by potash only, and by both potash and phosphate, burning without fertilizing, and lastly manuring the burned land.

The weather of the first crop season was exceptionally favorable—no summer frost and a favorable precipitation. Excellent crops were secured wherever phosphate, manure, or burning was employed. The potash, both alone and in combination with the phosphate, was of no distinct benefit and the manure did not improve the burned land. The crops reacted alike with fertilization, with the exception of flax, which was a complete failure on the burned plots, and which alone gave a fair yield on the unfertilized, unburned peat. The results of the work in 1918 were reported on pages 108 to 143 of volume 13, number 2, of this Journal.

Much more extensive experiments were started in the second season, which opened favorably. All crops did well until a severe frost on June 3 killed the flax and injured many other crops, but all except flax and buckwheat recovered. Wherever the peat had been burned off there was no frost injury. At the end of June the promise was as bright as the year before and very heavy hay crops of brome, western rye, and timothy, were almost ready for the mower. On the first of July over 5 inches of rain fell at Golden Valley and during the next 48 hours almost 4 inches more. To the eastward even more rain fell and a net-

work of more than 400 miles of ditches brought the flood waters down upon Golden Valley on their way to the Thief River. The narrow tortuous channel of this river could not carry the water off as fast as it flowed in, and for a week after the rains had ceased the water at the junction of the big ditch and the river continued to rise. Our fields were flooded and remained under water, or with a water-logged soil, and under a hot sun until most of the fine crops died. On the unburned peat winter rye and hay crops were gathered several weeks later but all others were entirely lost. On the burned field redtop, sown as part of a grass mixture on many of the plots of small grains, alone survived and as the water receded the redtop took full possession of the ground. The yields of hay and winter rye, as well as the appearance of the other crops at the time of the flood, confirmed the findings of the first season—phosphate hunger only.

The disappointing feature of the situation lay in the fact that our main experimental field had been selected with a view to avoiding just such a contingency. The field was so situated with regard to the great ditch that if it were surrounded by a hand ditch it would be the least subject to overflow. In the fall of 1918 a contract for this protecting ditch had been let to some nearby farmers, but an influenza epidemic prevented their carrying it out. Had the ditch been dug this field would have been under water for only a few hours and the crops would have escaped injury.

The season of 1920 was so dry that the last trace of frost did not disappear from the peat until August. The fertilizer response of the crops, as in the first two seasons, has been to phosphate only. The yield per acre without phosphate was 1 bushel and with it 18 bushels.

The most interesting thing about Golden Valley is that it appears to be the only place in the world from which experimental data have been reported showing that there are peat soils that need only a phosphate application to make them productive when first brought under cultivation, potash, either alone or combined with phosphate, being without effect.

THE COON CREEK TRACT

On the southern tract at Coon Creek the peat is about four

A. Stands of winter rye at Coon Creek, Minn., showing effect of different cultural treatment.

B. Yields of clover-timothy hay at Coon Creek, Minn., showing effect of fertilizer.

CROPS RAISED ON PEAT LAND

feet deep and overlays sand at the edges and marl in the center. Lime-deficient sandy soil surrounds the bog and blueberries grow naturally on this sand only a few yards from the edge of the high-lime peat. There is nothing exceptional in the behavior of the soil at Coon Creek unless it is that acid phosphate when used alone often depresses the crop yields. Potash used alone generally improves the yield, but to obtain really satisfactory crops a combination of potash and phosphate must be used. (See Pl. II.) Summer frosts appear much less frequently than on the northern bogs and up to the present time have caused but little injury. The clovers and grasses do well and good stands may be secured at almost any time of the season.

The chief industry of the neighboring farmers is the production of potatoes and dairy products for Minneapolis. On their light sand they are nearly always short of both clover hay and pasture grass, and of course short of stable manure. Hence there appears to be no obstacle to the rapid and profitable reclamation of this great tract of peat and to its employment largely for the production of tame hay and pasture grass, with smaller areas for oats and corn and sunflowers for ensilage. Potatoes will also probably prove one of the most profitable crops.

THE FENS TRACT

The northeastern tract is at Fens, 50 miles north of Duluth. It is in the midst of a tamarack swamp and a mile from the nearest mineral soil. The trees originally on it, although 150 to 250 years old, were too dwarfed to afford any merchantable timber. A mat of sphagnum and heath plants occupied the spaces between the trees. The peat, 8 to 10 feet deep, is so thickly studdded with roots and logs for at least 4 feet in depth that the removal of all woody fragments in preparing the seed bed is a very expensive operation. Such a complete removal may probably be avoided if tillage implements built on th principle of the Australian stump-jump plows, cultivators, and drills are used. The single-disk grain and fertilizer drill, which can ride over stumps, is also well adapted to such land. Ordinary mold-board plows are almost useless and only an especially

heavy disk plow was found workable, and this only partially satisfactory.

The initial chemical requirement is like that at Golden Valley, viz., phosphate only, potash being without effect. Lime seems to exert a depressing effect upon most crops and nitrogen fertilization, though often helpful, is not necessary for the ordinary farm crops when a suitable rotation is used. Here also the burning of a layer of peat, 6 to 8 inches thick, supplies sufficient available phosphate for a time. In order to get rid of the natural covering of moss, shrubs, and woody fragments they must be burned. This, however, is not equivalent to the burning of the surface of the underlying peat.

Summer frosts play a leading role at Fens. In 1918 at the end of June a frost killed the flax and froze the potatoes and barley down to the ground. Both the potatoes and barley started again and were growing rapidly when killed at the end of August by a second frost. In 1919 no frost came until the end of August, by which time crops were beyond any serious injury. In 1920 four frosts, on July 14, 15, and 31, and August 21, were severe enough to injure or kill the buckwheat, millet, and potatoes on the well drained peat.

In the favorable season of 1919, on the properly fertilized land, we secured upwards of 250 bushels per acre of potatoes, from 24 to 34 bushels of winter rye and as high as 4 tons per acre of timothy and clover hay. Spring grains, with the exception of field peas, gave poor yields. In 1920 hay, pasture grass, and peas were again good; winter rye not so heavy; flax, barley, and wheat very poor; and oats only fair.

The grasses and the common clovers, red, alsike, and white, usually do well when the soil is kept moist enough. We are able to count upon good hay yields and good pasture grass. Farming at Fens is essentially a hay and pasture proposition. For this reason we have put in an automatic water control system, and during the growing season the water level on six small tracts is maintained at six different levels, viz., 12, 18, 24, 30, 36, and 48 inches below the surface. This experiment has as yet given us little information as the rains of the past two seasons have been so heavy that all the plots have had an abundance of moisture. In drier seasons we may expect marked differences in yields.

One observation of interest in connection with the water level experiment may be mentioned. The frosts at the middle of July, 1920, largely killed the potatoes where the water levels were kept at the 36, 30, and 24 inch levels, but did no injury to those on the 18 and 12 inch plots, indicating that overdrainage increases the danger from summer frosts.

LOW-LIME BOG AT GRAND RAPIDS, MINN.

At one of the university's substations at Grand Rapids, north-central Minnesota, there is a small, typical low-lime bog on which in 1914, and to a lesser extent for a few years following, some experimental work was done. That was before we secured the tracts at Golden Valley, Coon Creek, and Fens. The peat is highly acidic, but when given 2 tons per acre of ground limestone, as well as both phosphate and potash, and with non-legumes and nitrogen, it produced very good crops except when the crops were injured by the numerous summer frosts. This bog is so poorly suited for the purpose that experimental work on it has been discontinued.

It would have been very misleading to have assumed, simply because this bog was on one of the substation farms, that it was typical of the peat lands of the state in general, and on the strength of the experiments on it to have made recommendations as to the handling of Minnesota peats. The chemical investigation prevented any such mistake.

VARIOUS EXPERIMENTS STARTED

At Coon Creek sand appled to the surface at the rate of 300 tons per acre has increased the hay yield both where no fertilizer has been added and where fertilizers are used. At Golden Valley boulder-clay, taken from the waste bank of the big ditch and applied at the rate of 200 tons per acre, has shown little effect. If mineral soil is to be applied profitably in this country it will probably have to be done with hydraulic machinery, much as the sand overburden is stripped from the iron ore on the Cuyuna iron range.

Of the various experiments which have been in progress only a short time mere mention should be made. We are trying the

various forms of phosphate—bone meal, raw rock phosphate, treble superphosphate, and acid phosphate—and these at various rates. Where potash appears to be beneficial we are using it at various rates. Lime has been tried at Fns and Coon Creek and stable manure on all three tracts. At Golden Valley peat ashes, such as would be obtained by burning peat ranging in thickness from 1 to 36 inches, have been applied, and the Spalding deep tiller has been used on a shallow peat to bring up the underlying mineral soil.

Adjacent to our bog at Coon Creek we have a sand experimental field and on it this year we have raised various crops on plots treated with peat at the rate of 10, 20, and 40 tons per acre. Peat compositing with various proportions of stable manure since last October is now ready for application on the sand field.

At all three places the Section of Plant Breeding is trying many varieties of oats, barley, and wheat, and the Section of Farm Crops is making plot trials of the most promising varieties of grains, forage crops, grasses, clovers, and grass mixtures.

POTASH A PROBLEM EVEN AT FENS AND GOLDEN VALLEY

Our ability to secure good yields without potash fertilization at Golden Valley and Fens is to be regarded as only a matter of a few years at most, unless the initial supply of potash be conserved by confining the use of the land to pasturage. On some of the very shallow peats the mineral subsoil may be able to supply the needed potash. Thus with sulphate of potash at $150 to $200 per ton, the seriousness of the potash problem is not being overlooked.

BURNING

I fear I frequently am mistakenly regarded as an advocate of the extensive burning of peat lands in order to make them productive. This is doubtless the result of the excellent crops secured at Golden Valley, both where the peat was simply burned over and where it was burned off. Hundreds of visitors saw those crops and the station reports have stated the facts.

The advantages and disadvantages of burning may be briefly

stated. Burning renders available a large amount of phosphate, a small amount of potash, and somewhat increases the availability of the nitrogen in the peat below the burned layer. If the soil has an initial chemical requirement of phosphate only, th burning produces a most surprising benefit. Even if it needs potash as well, a good crop or two may be obtained, and even on low-lime peats enough lime may be set free to give a fair crop for one season.

In preparing some peat lands, as at Fens, more or less burning of the surface is almost unavoidable. In some cases, as at Golden Valley, the tough fibrous surface is very difficult to cultivate and its removal would be an advantage if this could be effected cheaply enough, but usually it will probably be so expensive that even there burning is to be considered a practice of very doubtful economy.

The disadvantages of burning need merely be mentioned. By lowering the surface it may ruin the drainage sysetm and leave the surface so pitted as to require additional expense to drain the burn-outs; it may bring to the surface a boulder field that had been buried in the peat, a poor sandy soil containing too little organic matter, or an alkali flat; and the danger of the fire escaping and doing serious damage is great.

Where the surface has been accidentally burned, advantage should be taken of this and if the surface is not too rough it should be disked and planted with some crop before weeds take possession. On some bogs as an aid in first bringing the land under cultivation, burning is justifiable or even advisable, if intellignetly employed. In northern Minnesota at times there is a place for burning, but on the bogs of southern Minnesota I have seen no place where it was justifiable.

SOIL SURVEY

BELVIDERE AREA, NEW JERSEY

BY AUSTIN L. PATRICK AND OTHERS
United States Department of Agriculture.

Muck

Muck consists of black, well-decomposed vegetable matter containing some inorganic or mineral material. The organic deposit is 24 inches or more in depth, and is underlain by gray or pale yellowish-gray silty clay, sandy clay, or clay. This passes quickly into greenish-gray loamy fine sand or fine sand, which in most places contain some shells. A brown mass of partially decomposed organic matter is often encountered in the areas of deep muck at depths varying from 8 to 20 inches. This layer is usually several inches thick and is underlain either by black muck or by the above-described clay or sand. In some places along the southern end of the Great Meadows (Pequest Meadows) the organic deposit is said to be 25 or 30 feet deep. Three classes of muck are recognized—typical muck, an intermediate phase, and a shallow phase. These are mapped separately, but patches of interemediate and shallow muck are included with the typical muck where too small to separate, and patches of deep muck are included with the two phases for the same reason.

Important areas of typical muck occur in the Great Meadows region, in the "Tamarack Swamp" south of Mountain Lake (Greens Pond), between Vienna and Hackettstown, and north of Mount Bethel, and similar patches here and there within the glacial region. The type occupies flat, swampy depressions marking the site of glacial lakes. Numerous large ditches, with smaller laterals, are necessary in order properly to drain these swamps.

Water maple, elm, willow, and sycamore are the principal trees on this soil, though the growth in some of the swamps consists largely of tamarack or cedar. The undergrowth is abundant, consisting of smilax, ivy, ferns, and other water-loving flora. In places the swamps are more like marshes, and here reeds and marsh grasses are the principal plants.

The type is important agriculturally, all the larger patches

being cultivated. Celery, onions, and lettuce are the principal crops, occupying fully 90 per cent of the developed area. Corn does very well and is grown by some farmers who have only a small patch of muck adjoining fields of upland soil. In some cases where this type has been partly reclaimed it is used for pasturing herds of dairy cows during periods of drought. It is only during such times that it is possible to allow stock to pasture on it, because of its miry nature.

Onions ordinarily yield from 400 to 800 bushels per acre. Growers state that from 600 to 700 bushels is considered a fair crop, but 900 bushels is often obtained. Varieties of white, yellow, and red onions are grown. Celery is the principal crop on most muck farms. Large yields of excellent celery and lettuce are obtained.

Muck is held for the most part in large tracts and leased to tenant farmers in plots of 8 to 15 acres. The tenants are nearly all foreigners, largely Poles. As a rule the whole family helps with the work. The land is plowed in the fall or early in the spring, with 1 or 2 horse turning plows. The seed is sown in rows usually 12 to 18 inches apart. The crops receive many cultivations during the season, small hand cultivators being used. A few growers plant the seed in rows 3 feet apart, and till with a one-horse cultivator. The common practice is to plant lettuce early in the spring and as soon as this crop is harvested to follow with celery or onions, which are harvested during September, when lettuce is again planted to be harvested the same fall, provided frosts do not come too early. Sometimes onion seed is planted in September for "sets." Another common system is to plant early white onions in April and follow these with celery. Two crops of celery can be obtained, provided the season is favorable, and seed for the second crop is sown between the rows of the first crop before the latter is harvested.

Boards are used to bleach the celery in the field. The crop is washed, bunched, and packed in crates. Lettuce is packed in boxes, while onions are shipped in baskets or bags and are sold by the bushel or by the hundredweight. Many buyers come directly to the farms. Each year an increasing percentage of the crop is hauled to the markets over improved roads in automobile trucks.

The fertilizer formerly used was the common 2-8-10 prepa-

ration, and 1 ton to the acre was the usual application. Since potash is so hard to get the growers use any kind of fertilizer they can obtain. In 1917 some used 1 ton of a 2-8-3 mixture to the acre, while others used the same amount of a 1-10 or 2-10 preparation. Some growers believe that the shortage of potash was the direct cause of the practical failure of the lettuce crop of 1917. Stable manure is used by some growers, but they report that weeds are nearly impossible to control when this is used, though the effect on the crops is very beneficial.

Muck lands are rented under both the share and cash rent systems. Under the former the owner furnishes everything, including the seed and fertilizer. He also plows and prepares the seed bed, and hauls the crop to the freight station. The operator furnishes the labor only, and each receives half the crops. The owner directs the work and has charge of selling the crops. Under the cash system the renter pays $15 to $20 an acre, besides paying rent for the house and barn. The many smaller details are arranged variously by different persons.

Areas of muck large enough to sell separately bring from $75 to $500 an acre, depending upon the extent of clearing and reclamation, as well as the condition of the ditches, the nearness to good roads, the depth of the organic material, and the buildings. Under the best conditions it is the highest-priced land in the Belvidere area.

The intermediate phase of muck consists of black muck exactly like the typical soil except for the shallower depth to the underlying clay, sandy clay, or loamy sand, which is reached at depths usually ranging from 10 to 24 inches. The intermediate phase occurs associated with the typical muck and is used for the same crops. It has a somewhat lower value on the market, though there is no marked difference in its productiveness.

The shallow phase differs from the typical muck in that the organic layer is not more than 10 inches deep, usually ranging from 8 to 10 inches. The area south of Mountain Lake (Greens Pond) seems to have more shell material in the sandy layer than does the typical muck. The large area mapped at Oxford consists of black muck which grades at 8 to 10 or 12 inches into a brown mucky clay, this passing quickly into a bluish-gray clay Near Oxford station the black muck grades into a black mucky clay, which in turn passes down through a bluish-black clay into

rusty-brown clay. The subsoil clay of the whole Oxford tract is more plastic and less sandy than the lower subsoil of the typical muck and the intermediate phase.

The largest bodies of the muck, shallow phase, occur near the upland in the Great Meadows region, south of Mountain Lake, and near Oxford. Part of the phase has been reclaimed, though it is the least improved of the muck soils. Much of it has been cleared and partly reclaimed by ditching, and is used for pasturing dairy cattle during the dry summer months. Part of the Oxford tract, as well as much of the Great Meadows and other tracts, is devoted to the growing of onions, celery, and lettuce. Here the yieleds compare favorably with those on the deeper muck.

ABSTRACTS OF PATENTS

Peat Soil Fertilizer

By Nils Tesrup

Claim.—1. A method of preparing a soil fertilizer consisting in subjecting of heat treatment adapted to destroy its water binding properties so that its fertilizing constituents may be augmented by the addition of agents which will be temporarily fixed by the acidity generated therein by the heat treatment process.

Claim.—2. A method of preparing a fertilizer from peat consisting in subjecting it to heat under pressure sufficient to prevent evaporation to destroy its water binding and develop its acid properties and employing the resultant material as an absorbent for ammonia.

Claim.—3. A method of preparing a fertilizer from peat consisting in subjecting the peat to a temperature of from 100° to 180° C. under pressure sufficient to prevent evaporation, dewatering the resultant material, subjecting part thereof to gasification under ammonia production conditions, and utilizing another part to absorb ammonia from the gases thus generated.—Canadian Patent 207, 257.

Manures

By R. Bengough

Vegetable and animal substances used as food for micro-organisms in the fermentation process described in the parent specification are themselves rendered assimilable when used as manure, by fermentation. The substances may be first treated with steam, acids, or alkalies. Mineral fertilizing materials, which may have been treated as described in the parent specification, may be added before, during, or after the fermentation process. The fermentation may be promoted by heating. For use the material may be dried or mixed with absorbents. A natural or artificial culture of micro-organisms may be added, and in this case the mixture may be subjected to a supplementary dry fermentation. A manure prepared from straw is described as an example. The straw, first treated with acid and cut into small pieces, is made into a thick paste with water, neutralized,

and caused to ferment by the addition of organisms capable of fermenting cellulose. The fermentation is maintained and promoted by the addition of kieserite and bog iron ore. Ash, peat powder, and fine soil are added to make the product easily distributable.—British Patent 148, 560.

Making Peat Briquettes—Pumping Plant

By E. P. Ulman

In the manufacture of peat-briquettes, the peat mass in disintegrated and mixed with water to form a homogeneous peat-porridge in a multistage screw pump, which also forces the mixture through a jointed pipe-line directly to a drying area over which it is spread in a thin layer and afterwards cut up by suitable means. The sections of the pipe-line are removed as one drying area becomes covered with the peat porridge and are relaid to form the pipe-line for the next drying area. One form of plant comprises a derrick movable transversely on rails, carrying a multistage screw pump driven by an electromotor supported on the frame of the pump driven by an electromotor slung on a chain by which it can be lowered into the peat-mass which has been eroded by a water jet or other means, and mixed with water. The pump is connected to the pipe-line by flexible sections and a telescopic section. The pump comprises a number of rotors secured to the shaft, revolving in casing units which are separated by other units fitted with guide blades. The cross-section of the channels through the rotors diminishes and that through the stators increases in the axial direction of flow. The first rotor may have a wider inlet and may have a cutting-face coacting with a fixed cutter to disintegrate large masses of material entering the pump. Additional blades may be fitted to hold away from the pump larger pieces of root and hard bodies and to agitate the peat-mass. A centifugal pump may be arranged above the screw pump to assist in forcing the peat-porridge along the pipe-line. In a modified plant the pump unit is carried on a block on a trolley on a rope railway stretched between towers which house the controlling machinery.—British Patent 149,869.

Drying Peat

By T. Boberg

Peat and other substances are dried in two gases, or the like.

The peat pulp is heated in surface heaters and a direct-contact heater and thence passes to a trough into which dips a rotating drum. The overflow from the trough falls into a trough whenre it is returned to the heater. The partly dried material is removed from the drum by a scraper and passes to a trough containing a worm conveyor whence it passes to a briquetting-press. Furnace-gases from a boiler furnishing steam for the plant pass through the trough in the opposite direction to the material. The steam from the boiler drives a turbine, the exhaust from which heats the drum, which is also heated by the vapour from the peat, which is compressed by a pump till it reaches a temperature of about 105° C. Steam is taken from an intermediate stage of the turbine to drive the briquetting-press, and the exhaust from the press is passed to the drum. Surplus vapour from the material and waste steam from the drum are utilized in the heaters, and water of condensation is used to heat the heater. In a modification the trough and conveyor are replaced by an arrangement in which the half-dried material is suspended in a current of hot air and the dried material separated in cyclone separators as described in specifications 16958/11, 24748/11, and 17426/12. The vapour generated in the second state or drying may be utilized as described in specification 12013/10.—British Patent 150, 807.

Peat Fuel

By N. Long

Alkali is added to peat during its treatment in a mixing-machine, and the resulting product is left to dry in the air; preferably, the product is made up into blocks before being dried. The alakli is of a kind that will attack the water-holding cells of the peat without combining with the cell water and may be washing soda, potassium carbonate, borax, or like material.—British Patent 152, 515.

Combustion of Pulverized Fuel in Stationary Boilers

By the Fuller Engineering Co.

Claim.—1. The method of utilizing pulverized fuel in a stationary boiler having a furnace lined with refractory material which consists in introducing pulverized fuel and air into the furnace and igniting it therein, maintaining the supply of fuel and air

to the furnace substantially continuously to maintain continuous combustion within the furnace and causing the deflagrating fuel and the gases of combustion to flow through the furnace at low velocity, substantially seven feet per second, to substantially avoid erosion of the refractory walls of the furnace and to insure that combusion of the fuel will be complete within the furnace.

Claim.—3. The method of burning pulverized fuel in a stationary boiler having a furnace lined with refractory material which consists in introducing pulverized fuel and air into the furnace and igniting it therein, maintaining the supply of fuel and air to the furnace substantially continuously to maintain continuous combustion within the furnace, causing the deflagrating fuel and the gases of combustion to flow through the furnace in a path which bends back upon itself so that the hot gases of combustion will assist in igniting the incoming fuel, and causing the deflagrating fuel and the gases of combustion to flow through the furnace in said path of low velocity, substantially seven feet per second, to substantially avoid erosion of the refractory walls of the furnace and to insure that combustion of the fuel will be complete within the furnace.

Claim.—4. The method of burning pulverized fuel in a stationary boiler having a furnace lined with refractory material which consists in introducing pulverized fuel and air into the furnace and igniting it therein, maintaining the supply of fuel and air to the furnace substantially continuously to maintain continuous combustion within the furnace, causing the deflagrating fuel and the gases of combustion to flow through the furnace in a path which bends back upon itself so that the hot gases of combustion will assist in igniting the incoming fuel, and causing the deflagrating fuel and the gases of combustion to flow through the furnace in said path at a velocity which is less than seven feet per second to substantially avoid erosion of the refractory walls of the furnace and to insure that combustion of the fuel will be complete within the furnace.—Canadian Patent 205, 710.

Method of Treating Peat

By W. W. Blair

Claim.—1. The method of treating peat which consists in macer-

ating the freshly dug peat mass, compressing the same into blocks, drying the blocks and then impregnating the blocks with a fuel oil.

Claim.—4. The method of treating peat which consists in breaking up the peat mass, compressing the same into blocks drying the blocks and then soaking the blocks in oil.

Claim.—7. The method of treating peat which consists in pressing the unmacerated peat into blocks, drying the blocks and then impregnating the blocks with a fuel oil.—Canadian Patent 205, 786.

Treatment of Peat

By Wm. B. Bottomly

Claim.—1. A process for producing auximones in peat, which consists of first developing a nucleic acid derivative in the peat by moistening the peat with a solution of a salt which is not alkaline, and heating this moistened peat under conditions for retaining water therein, and then placing the peat under conditions suitable for growth of micro-organisms.

Claim.—7. A process for treating peat for this purposes herein set forth, which consists in moistening the peat with a solution of a salt which is not alkaline and then heating the moist peat to a temperature above 100° C. while it retains water.

Claim.—13. A treatment of peat which consists in mixing salt peat with 2-10 per cent of its dry weight of common salt dissolved in 5-10 times its weight of water, heating the mixture with steam at a temperature of above 100° C. in a loosely covered vessel, and then spreading the peat on a heated floor and sprinkling it with water containing micro-organisms.—Canadian Patent 206,416

CURRENT COMMENT

Fertilizer Needs of Peat Marshes.

Among many interesting items that appear in the recent annual report of the Director of the Experiment Station of the University of Wisconsin, published as Bulletin 319, "Experiments in Farming," is the following relating to the work done by Professor W. W. Weir in determining the fertilizer requirements of marsh soils

Carefully controlled experiments instituted by W. W. Weir (Soils) on the fertilizing needs of the University marsh have been carried on by laying out fields in three-year rotations, using corn, barley, or rye and alsike clover and timothy. The fertilizer treatment applied this year was used with the corn. Control plots gave a crop of 38.5 bushels an acre, while those receiving fertilizer applications ranged from 71 to 91.9 bushels an acre. It is evident from the results of these experiments that potash is the element most markedly needed by corn growing on this type of soil, and that with a good application of fertilizer containing this element, heavy yields can be produced. Since it was impossible to secure muriate of potash for use this year, cob ash containing 25 per cent of potash has been used.

No particular benefit seems to have developed from the addition of a phosphate fertilizer. It should be mentioned, however, that this particular marsh is not now in an acid condition, but it should be borne in mind that further cropping is quite likely to exhaust the available supply of phosphate, making the use of such fertilizer in addition to potash necessary later.

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ANNOUNCEMENT OF THE FIFTEENTH ANNUAL CONVENTION.

EXECUTIVE COMMITTEE NAMES NEW YORK CITY, SEPTEMBER 7, 8, AND 9.

At a meeting of the executive committee of the American Peat Society on May 23 it was decided to hold the Fifteenth Annual Convention at the Hotel Commodore in New York City on September 7, 8, and 9. The committee is making elaborate plans for the event and guarantees in advance that it will be the most interesting and entertaining meeting in the annals of the organization.

New York was selected on account of its nearness to the bogs of both that State and New Jersey, where peat is more extensively utilized than in any other region, because of the facilities of that city for wide publicity, and for the further reason that there will be a meeting of the American Chemical Society in New York on the same dates, which should greatly increase the probabilities of large attendance.

Illustrated papers will be presented by the foremost authorities on peat in the United States. The program will include a wide variety of subjects—air-dried machine and powdered peat fuel, the cultivation of peat soils, the application of bacteriology to soil fertilization, the use of peat as a nitrogenous ingredient and conditioner of fertilizer and stock food, the efficient handling of peat, false promotion, inefficient engineering, and other

subjects. An important announcement concerning the status and prospects of the society will be made by one of the officers.

Every peat producer and owner or operator of peat and muck land in the United States should attend this convention. Loyalty to the society requires the attendance of members, but others are welcome to come and learn the scientific possibilities and commercial value of peat and muck as crop soils, fertilizer and stock food ingredients, and fuel for domestic and industrial purposes.

A CALL FOR INCREASED MEMBERSHIP.

By C. C. Osbon.

The overshadowing need of the American Peat Society is increased membership and finances. The society was organized in 1907, and though its growth has been encouraging, the admission must be made that, as a scientific association devoted to the diffusion of knowledge concerning peat and to the utilization of American peat resources, we have fallen far short of our possibilities. The default may be charged to the lack of genuine interest by many of the members and officers in the expansion of the membership, to the small attendance at conventions, to the failure of some person to suggest and supervise a definite membership campaign in which all will cooperate, and to the lack of publicity. The executive committee has devoted much thought to the matter during the past year and it hopes that increased membership may be given the attention it deserves at the next convention.

Small Income Wisely Expended.

The interested officers with the means at their disposal have done well. The present membership is less than 300. The annual subscriptions are $5.00. The printing cost of the quarterly journal requires almost the entire income. All officers, some of whom devote much time to the business of the society, serve without compensation. The small balance of the income not paid to the printer of the journal is used to defray the miscellaneous expenses of the executive committee. The committee constantly finds itself handicapped by lack of funds. The journal goes to practically every important country throughout the world and has earned a reputation as a unique scientific publication of the first order. With the added funds that greater membership would make available it would be possible greatly to increase the circulation of the journal, to obtain advertising that can not now be secured, to point out more effectively the value and possibilities of peat, and thus to further the science and the commercial interests of peat owners.

Possibilities Almost Unlimited.

With the stimulus of new life and interest in our organization its possibilities would be almost without limit. There are 14 billion tons of peat in this country and the average sale value to the producer of the peat marketed here in recent years closely approximates $10 per ton. Our annual production is less than 100,000 tons. The membership of the society is less than 300 and there are over 30,000 owners of peat land in the United States. If the work that the society is doing and the benefits of membership were properly presented could not our organization be greatly expanded?

Next Convention Should Inaugurate Membership Campaign.

The time is here for new life and interest. The coming convention should be well attended. It will be interesting and entertaining. A committee on membership and State sub-committees should be appointed and an effective program for expansion adopted. Every person in the society should cooperate to the extent of personally securing new members among his acquaintances and pledging a sum to further the movement. Some of the members of the executive committee have given the membership the benefit of hundreds of dollars annually in terms of their time.

Publicity a Vital Factor.

Publicity will be the determining factor in the campaign. Our society is not widely known and the benefits of membership not fully appreciated. There are many owners of peat land who have never heard of us and who do not realize the potentialities of peat. There must be a publicity plan that will overcome these barriers. As will be noted from the proceedings of the executive committee published in this issue, such a plan has been devised by the executive committee and Messrs. M. W. Robinson and Hoff have kindly agreed personally to extend financial aid. If a membership campaign is launched at the next convention the committee should of course enlist the aid that will be afforded by the plans and finances mentioned.

A SUCCESSFUL COOPERATIVE EXPERIMENT ON A POTASH-HUNGRY PEAT OF DOUBTFUL LIME REQUIREMENT.[1]

By F. J. Alway, P. R. McMiller and C. O. Rost.
Agricultural Experiment Station, University of Minnesota.

Introduction.

In Volume 14, No. 2, of this Journal one of the authors of this paper reported experiments conducted at the Golden Valley, Minn., peat experimental fields in which none of the crops in the first season (1918) showed any benefit from the application of potash, either alone or in combination with phosphate, whereas phosphate had a most markedly beneficial effect upon the growth of all the trial crops except flax. In this paper we report a cooperative experiment conducted during the same season on the Forest Heights bog in southern Minnesota in which almost the opposite responses were shown—potash when used alone producing a most marked benefit, and phosphate when applied alone of no benefit and of positive detriment to some of the crops. Incidentally the work affords an excellent illustration of a successful cooperative experiment.

General Features.

The chemical composition of the soil called for a field experiment to decide whether liming would be necessary. The experiment showed that lime was without beneficial effect, since just as heavy yields could be obtained without as with it. Within less than a year from the time the land was first plowed the question of the need of lime and fertilizer was fully answered.

The bog is about two acres in area and lies among sandy hills a few hundred yards from the eastern shore of White Bear Lake, immediately beside the Forest Heights station on the electric line from St. Paul to Mahtomedi. It was covered with a natural growth of sedges and grasses, and had remained undisturbed until the autumn of 1917 when its owner, Mr. Ralph

[1]Published with the approval of the Director of the Minnesota Agricultural Experiment Station as Paper 224 of the journal series.

Dake, of Willernie, installed a tile drainage system and plowed the northern half about eight inches deep. During the following winter he applied to the experiment station for advice regarding its fertilization and cropping. The location of the bog and its unusual content of lime, neither high nor low, gave it an especial interest, and a cooperative experiment was arranged for the crop season of 1918.

As shown by Plate I., the depth of the peat varies from less than a foot at the sides to more than 5 feet near the center. No roots or logs were found in plowing, from which it was evident that, unlike many other bogs in the district, it had never been overgrown by tamarack trees. The peat in the surface layers was brown, fibrous, and poorly decayed.

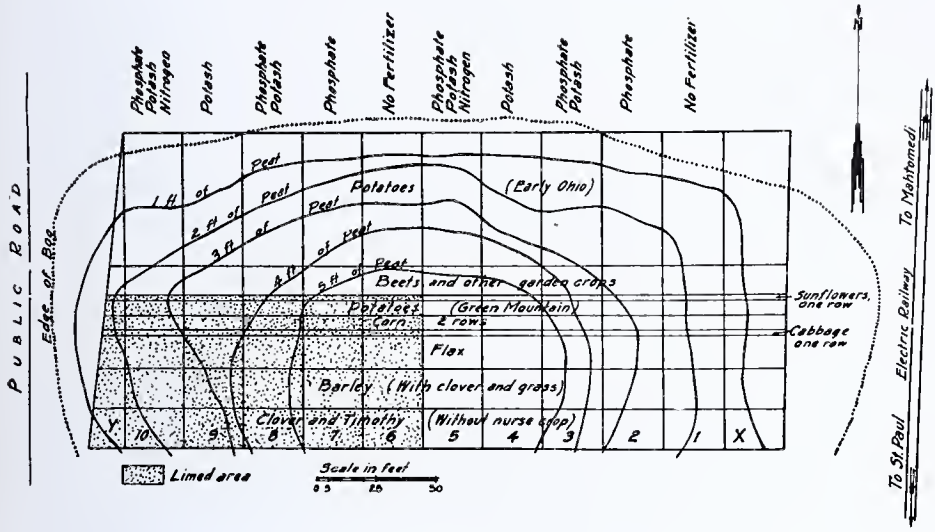
Chemical Composition of the Peat.

The chemical composition is shown in Table 1. The composite surface sample was prepared from many small specimens taken from various places on the prepared seed bed. The three other samples taken at successive levels were prepared by combining equal weights of 6-inch blocks taken from seven places on the unplowed land lying just beyond the southern edge of the portion devoted to clover and timothy. They show the chemical composition of the part of the bog that contains peat 30 or more inches in depth.

Table 1. Chemical composition of the peat at various depths in the bog at Forest Heights, Minn.[1]

	Surface composite.	1 to 8 inches.	9 to 16 inches.	17 to 24 inches.
Volatile matter	79.50	76.12	85.68	86.62
Ash (total mineral matter)	20.50	23.88	14.32	13.38
Lime (CaO)	1.01	0.98	1.17	1.21
Phosphoric acid (P_2O_5)	0.38	0.38	0.25	0.22
Nitrogen	2.92	2.93	2.84	2.87
Potash (K_2O)	0.09	.....	.....	.....

[1]Analysis by the Bremen method (Ignition and extraction of resulting ash with aqua regia).
Konig, J., Untersuchung landwirt, und gewerb, wicht, Stoffe, p. 111-128, Aufl. 4, 1911.
Rost, C. O., and Clapp, F. C. Determination of lime and phosphoric acid in peat soils; Soil Sci., Vol. 5, p. 213-218, 1918.



SKETCH OF FOREST HEIGHTS, MINN., BOG, SHOWING DEPTH OF PEAT IN PLOWED PORTION, FERTILIZATION, AND CROPPING IN 1918.

All four samples are true peats. The surface section contains the largest amount of mineral matter, but much of this consists of coarse sand probably blown over the bog within the past few decades from the surrounding sandy hills. The proportion of phosphoric acid appeared to be inadequate. The nitrogen content was normal, and the potash in the surface layer—the only one in which it was determined—was very low, although it amounted to about the same as in the Golden Valley peat, which gave no response to potash fertilization.

The lime supply is the most interesting chemical feature of the peat in this bog. All of the samples from the surface gave a distinct acid reaction ("medium" as determined by the Truog method). The percentage of lime was too low to justify the omission of liming in the experiment, although it was higher than in typical low-lime peats. The question of the lime requirement could be established only by a vegetation or field experiment.

Fertilization and Crops Sown.

After the depth of the plowed portion of the bog had been determined it was staked out in ten sections, each of which it was planned to give different treatment. Early in May, 1918, it was disked several times and harrowed. On May 14 ground limestone was applied to the southwest quarter at the rate of two tons per acre, and three days later phosphate and potash were added to the portions indicated on Plate I. The nitrate was not applied to sections 5 and 10 until early in June. The quantities applied are shown in Table 2.

No alleys were left between adjacent sections, but later in the season, just before harvesting each crop, spaces 2 feet wide on the dividing lines were made in order to eliminate the effect of the treatment of adjacent plots. Flax, barley mixed with red clover, alsike, and timothy, and also this same grass mixture without a nurse crop, were sown on May 18. The remainder of the tract was soon thereafter planted by the owner with various garden crops in rows running the full length of the field. In some instances only a row or two of each plant was sown.

TABLE 2. FERTILIZATION AND NUTRITION.[1]

Plot Nos.	Fertilization.		Additional Nutrients.		
	Name of fertilizer.	Quantity (pounds per acre).	Phosphate (P_2O_5) (pounds per acre).	Potash (K_2O) (pounds per acre).	Nitrogen (pounds per acre).
1 and 6	None	0	0	0	0
2 and 7	Acid Phosphate	800	120	0	0
3 and 8	Acid phosphate	800	...	...	...
" "	Nebraska potash salts	500	120	140	0
4 and 9	Nebraska potash salts	500	0	140	0
5 and 10	Acid phosphate	800	...	...	...
" "	Nebraska potash salts	500	120	140	32
" "	Nitrate of soda	200	...	...	...

[1]Ground limestone amounting to 2 tons per acre was also applied to the southern half of sections 6 to 10.

The owner was in the army, labor could not be obtained, and as a consequence the crops were neither hoed nor weeded between planting and harvesting. A considerable amount of wild grass appeared among all the crops, but it probably did not seriously affect the yields. The cabbages and some of the other crops were injured by insects. Such a large part of the root crops, particularly the finest specimens, was carried away as souvenirs by the great number of self-invited visitors who came to see the experiment that not enough remained to justify weighing.

WEATHER DURING THE CROP SEASON.

The rainfall and monthly mean temperature compared with normal are reported in Table 3. The data were supplied by the nearest United States Weather Bureau station at St. Paul. The temperature from May to September departed but little from normal, but the total rainfall for the five months was slightly above normal. No frost appeared until September 21.

TABLE 3. RAINFALL AND MEAN TEMPERATURE IN 1918 AND DEPARTURE FROM NORMAL.

	Rainfall.		Mean Temperature.	
1918	Amount (Inches).	Departure from normal (Inches).	1918 (Degrees F.)	Departure from normal (Degrees F.)
May	4.52	+0.90	60	+2
June	2.81	—1.60	66	—1
July	5.05	+1.65	70	—2
August	5.19	+1.73	70	+1
September	1.49	—1.93	55	—6

In July and August, the months in which the crops were making the heaviest draft upon the soil moisture, the rainfall was greatly in excess of the average. During much of the summer the water level was lower than appeared desirable, and in a drier summer such a level doubtless would have materially reduced the yields.

CROP YIELDS.

Early in June the potash began to show a beneficial effect upon most of the crops, but the growth was much more vigorous where both potash and phosphate had been applied. To some of the crops where the phosphate had been applied alone a depressing effect was shown, but it did not appear to affect the others. The lime apparently did not distinctly benefit or injure the crops at any time. The plants in the small field, which gave no indications that it was being used for experimental purposes, soon assumed such an uneven growth that many automobile tourists who passed along the road on the west side stopped to ascertain the cause. The variation in the size of the plants in the several plots on July 9 is shown in Table 4.

TABLE 4. AVERAGE HEIGHT ON JULY 9 OF CROPS PRODUCED BY DIFFERENT TREATMENTS. (Height in Inches.)

Fertilizer.	Clover.		Barley.		Flax.	
	No lime.	Lime.	No lime.	Lime.	No lime.	Lime.
None	2	2	14	6	18	8
Phosphate	3	2	11	10	14	12
Potash	2	3	18	12	22	24
Phosphate and potash	8	11	36	39	36	36
Phosphate, potash, and nitrogen....	11	13	38	48	34	38

TABLE 4. AVERAGE HEIGHT ON JULY 9 OF CROPS PRODUCED BY DIFFERENT TREATMENTS. *(Continued.)*
(Height in Inches.)

Fertilizer.	Potatoes.		Corn.		Sunflowers.	
	No lime.	Lime.	No lime.	Lime.	No lime.	Lime.
None	10	9	8	6	10	9
Phosphate	10	11	8	11	10	11
Potash	10	11	10	12	10	11
Phosphate and potash	15	14	18	16	15	14
Phosphate, potash, and nitrogen	16	18	18	22	16	18

From Plate I. it will be seen that not all of the plowed land was included in the tract laid out into plots. In the sections on the east and west sides designated X and Y the peat was too shallow for experiment and the crops were not weighed. However on both of these the growth was much better than on the check plot No. 1, and the growth was much better on the east side of section X, where the peat was shallowest. All the yields reported in the tables that follow are from the portion of the bog on which the peat was at least 1.5 feet in depth. The Green Mountain potatoes reported in Table 5 and shown in Plate II. were gathered from the two rows next to the beets.

The hay was mowed on August 9 and weighed a few days later (See Table 5). There was a full stand of grass and clover on all the plots. Considerable wild grass persisted on the four plots that had received no potash, but there was almost none on the others. The hay showed no benefit from the phosphate, and much less from the potash alone than from the phosphate and potash, which caused an increase of more than 200 per cent in yield. The nitrogen was somewhat beneficial, but the lime had no distinct effect.

The barley, harvested on August 9, showed no benefit from the phosphate, but gave a much higher yield with the potash, and a still larger one with the two combined. The effect of the nitrogen was beneficial, but that of the lime uncertain. The grain on all the plots that received both potash and phosphate was ripe two or three days before that on the other plots.

A good stand of grass and clover was secured on all the plots,

5 4 3 2 1

10 9 8 7 6

POTATOES GROWN UPON PEAT LAND SUBJECTED TO EACH OF THE FOLLOWING TREATMENTS:

1. No fertilizer application.
2. Phosphate.
3. Potash and phosphate.
4. Potash.
5. Potash, phosphate, and nitrogen.
6. Lime.
7. Lime and phosphate.
8. Lime, potash, and phosphate.
9. Lime and potash.
10. Lime, potash, phosphate and nitrogen.

1 2 3 4

SUNFLOWERS GROWN UPON PEAT LAND SUBJECTED TO EACH OF THE FOLLOWING TREATMENTS:

(Plants were cut on September 26, 1918, from 15 foot row.)

1. Potash.
2. Potash and phosphate.
3. Phosphate.
4. No fertilizer.

and its growth, after the removal of the barley, was similar to that on the plots seeded without a nurse crop.

The flax on the four plots that received both the potash and phosphate was ripe on August 21, but the flax on the others was not ready to harvest until nine days later. The potash alone caused a 50 per cent increase in the yield of grain and an appreciable increase in the straw. The effect of both phosphate and lime was indistinct, and that of the nitrogen slightly beneficial. The potash alone gave practically as high yields as in combination with phosphate.

The potatoes were gathered on September 14, those from two rows weighed, and the yields computed. The effect of the phosphate alone was uncertain, the potash alone increased the yield from 50 to 200 per cent, and the combination of the two gave still larger yields. The effect of the nitrogen was beneficial on the early variety and indistinct on the later Green Mountain potatoes. Lime, used only on the latter, seemed without influence. The crop from rows of equal length is shown in Plate II. In appearance and cooking quality the potatoes were excellent.

The corn was cut on September 20 and weighed while green as used for silage. The potash greatly increased the yields and the addition of phosphate caused further improvement, but the effect of nitrogen was not distinct. Phosphate alone depressed the yields.

TABLE 5. CROP YIELDS OBTAINED FROM FOREST HEIGHTS BOG IN 1918.

Part of crop weighed.	Unit of yield.	Lime Treatment.	Fertilizer. None.	Phosphate.	Potash.	Phosphate and potash.	Phosphate potash, and nitrogen.
	Clover with Timothy						
Hay	Tons per acre	Unlimed	0.13	0.15	0.42	1.09	1.15
"	" " "	Limed	0.34	0.20	0.33	1.15	1.50
"	" " "	Average	0.23	0.17	0.37	1.12	1.32
	Barley						
Grain	Bu. per acre	Unlimed	15.00	5.90	(a)	(a)	45.20
"	" " "	Limed	4.00	3.20	18.10	27.40	30.80
"	" " "	Average	9.50	4.50	18.10	27.40	38.00
Straw	Tons per acre	Unlimed	0.43	0.34	(a)	(a)	1.49
"	" " "	Limed	0.31	0.32	0.77	1.20	1.15
"	" " "	Average	0.37	0.33	0.77	1.20	1.32
	Flax						
Grain	Bu. per acre	Unlimed	12.30	9.80	14.80	15.60	16.70
"	" " "	Limed	6.90	7.10	12.80	12.50	14.10
"	" " "	Average	9.60	8.40	13.80	14.00	15.40
Straw	Tons per acre	Unlimed	1.92	1.83	2.28	2.45	2.91
"	" " "	Limed	1.26	1.70	2.09	2.80	2.86
"	" " "	Average	1.59	1.76	2.18	2.62	2.88
	Early Potatoes (Early Ohio)						
Plots 1-5	Bu. per acre	Unlimed	38.00	27.00	105.00	156.00	217.00
" 6-10	" " "	Limed	42.00	79.00	137.00	193.00	235.00
" 1-10	" " "	Average	40.00	53.00	121.00	175.00	226.00
	Late Potatoes (Green Mountain)						
Plots 1-5	Bu. per acre	Unlimed	64.00	53.00	97.00	266.00	259.00
" 6-10	" " "	Limed	61.00	46.00	174.00	233.00	248.00
" 1-10	" " "	Average	62.00	49.00	135.00	249.00	253.00
	Corn						
Silage	Tons per acre	Unlimed	4.10	2.70	7.80	12.30	10.90
"	" " "	Limed	4.50	4.60	10.20	11.50	13.40
"	" " "	Average	4.30	3.60	9.00	11.90	12.10

(a) As the crops from plots 3 and 4 appeared to have become mixed in harvesting the data are not reported in the table. For the two the average yield was 19.1 bushels of grain and 0.88 tons of straw.

TABLE 5. CROP YIELDS OBTAINED FROM FOREST HEIGHTS BOG IN 1918. *(Continued.)*

Part of crop weighed.	Unit of yield.	Lime Treatment.	Fertilizer				
			None.	Phosphate.	Potash.	Phosphate and potash.	Phosphate potash, and nitrogen.
Sunflowers							
Dry matter in one row	Pounds	Unlimed	10.20§	5.20	12.20	34.00	30.30
" " " " "	"	Limed	6.10	7.90	24.00	32.90	33.20
" " " " "	"	Average	8.10	6.50	18.10	33.40	31.70
Sugar Beets							
Plots 1-5 (12 roots)	"	Unlimed	1.30	1.10	5.70	12.60	14.30
" 6-12 (12 ")	"	Unlimed	0.70	0.70	6.00	9.20	22.70
" 1-12 (12 ")	"	Average	1.00	0.90	5.90	10.90	18.50
Cabbage							
Representative head	"	Unlimed	5.00	4.50	4.00	17.00	17.20
" "	"	Limed	4.00	2.50	4.20	17.00	22.60
" "	"	Average	4.50	3.50	4.10	17.00	19.90

§On the east side of the plot, where the peat was shallowest, the plants were nearly twice as large as on the west side.

A frost, which occurred a few days before the sunflowers were cut and photographed on September 26, killed them on the plots that received no application of fertilizer, phosphate alone, lime alone, and lime with phosphate, but on the others, where the tops of the plants towered far above those on the plots mentioned, the frost killed only the lower leaves. Thus the crop on some of the plots was dry and on the others quite green. To secure a fair basis of comparison, the oven-dried weight was determined. As the beneficial effect of the potash on some of the plots appeared to extend several feet beyond the plot line, only typical plants or those from the center of each plot were weighed.

No crop showed a more marked response to the potash, to a combination of potash and phosphate, or to these materials together with nitrogen, than did the sunflowers, (See Plate III). Throughout the whole season the sunflowers conspicuously exhibited the effect of the fertilizer treatments. Sunflowers promise to prove one of the most satisfactory trial crops in determining the fertilizer requirements of bogs.

The sugar beets on all the plots that received both potash and phosphate were largely removed by visitors and only twelve were left on the plot that received lime, potash, and phosphate. These twelve were weighed and the same number of representative beets gathered from each of the other plots. The highly beneficial effect of the potash, of its combination with phosphate, and of the addition of nitrogen to these two materials, is evident from the table and from Plate IV.

With the cabbages the combination of potash and phosphate showed a marked effect. So many of the plants were injured by insects that the weights of representative heads best indicate the effect of the various treatments.

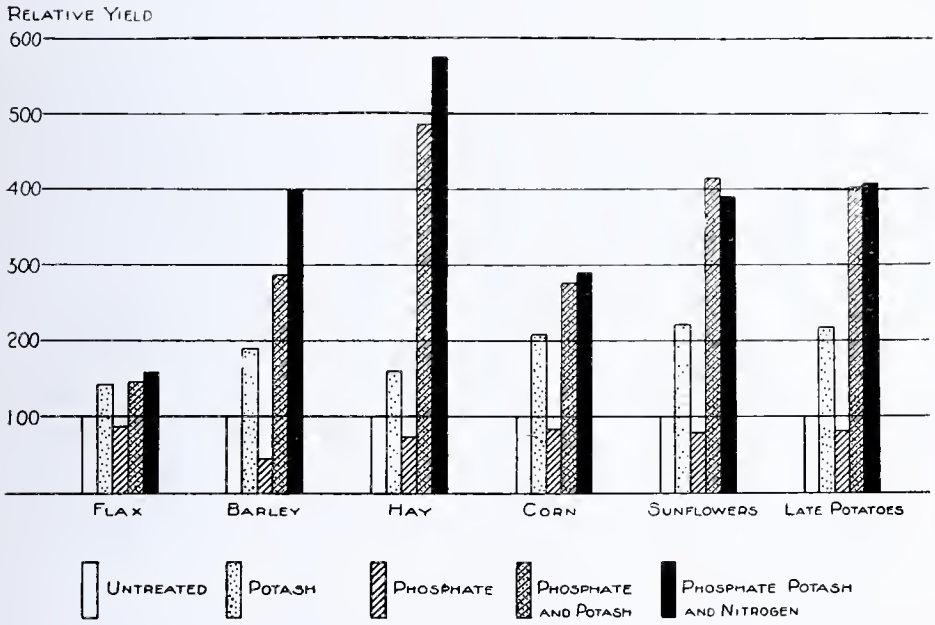
The other garden crops were not weighed, but the relative effects of the different treatments, so far as could be judged from the growth and size of the plants, were similar to those shown by the crops whose weights were obtained.

In 1919 the only portions of the field kept under experiment were those that had been seeded in clover and timothy, either alone or with barley, and on these only the first cutting of hay was dealt with. The rest of the plots were used for garden crops after applying either potash, phosphate, or both, according to

5 4 3 2 1

A. Twelve representative sugar beets grown on peat land subjected to each of the following treatments:

1. No fertilizer application.
2. Phosphate.
3. Potash and phosphate.
4. Potash.
5. Potash, phosphate, and nitrogen.



B. Comparison of crop yields from fertilized and unfertilized plots of peat. (Yield of unfertilized plots (100) used as basis for comparison.)

RELATIVE YIELDS OF CROPS FROM PEAT LAND SUBJECTED TO DIFFERENT TREATMENT.

whether they had been omitted the year before. There was a full stand of timothy on all the plots, and of clover on all except those receiving phosphate alone or phosphate and lime. The hay was cut on June 26, weighed while green, the moisture content determined, and the yields of the field cured hay computed. (See Table 6). The beneficial effect of a combination of potash and phosphate was as marked as in the first season, the lime was still without influence, and neither potash nor phosphate alone distinctly affected the yields.

TABLE 6. YIELDS OF HAY PER ACRE AT FIRST CUTTING IN 1919.

Fertilizer.	No lime.	Lime.	Average.
	Yield. (Tons).	Yield. (Tons).	Yield. (Tons).
None	1.91	0.75	1.33
Phosphate	1.63	1.18	1.40
Potash	1.28	1.03	1.15
Phosphate and potash	3.63	3.41	3.52
Phosphate and potash*	3.34	4.67	4.00
Average	2.36	2.21	. . .

*These two plots differ from the two preceding only in that they had received nitrogen the year before.

CHEMICAL REQUIREMENTS OF THE SOIL.

The foregoing data clearly establish the chemical requirements of the Forest Heights bog.

The influence of lime, shown in detail in Tables 5 and 6 is summarized in Table 7. The relative yields of the corresponding limed and unlimed plots were first in favor of the one and then of the other, the variations being so irregular that they should not be attributed to the effect of the application of limestone. The average relative yields for all the crops are practically the same—97 with lime and 100 without.

Hence, notwithstanding the distinctly acid reaction of the soil and the relatively low content of lime, there was sufficient lime for the crops during the first season after breaking. The future lime requirement of this bog is doubtful. There is not the wide margin in the supply that is characteristic of typical high-lime peats, that contain 1.50 per cent or more.[1] The under-

[1]Alway, F. J., Minn., Agri. Exper. Sta. Bull. 188, pp. 109-117.

lying layers are somewhat better supplied with lime than the surface, and the decay of the organic matter in the surface layer will steadily release lime. Only in the improbable case that more lime may be removed in the crops and in drainage than is thus set free will the lime content of the surface layer decrease.

TABLE 7. EFFECT OF LIME UPON THE YIELD OF CROPS. *

Crop.	Average yield from all 5 plots.	
	Without lime.	With lime.
Hay	100	84
Barley (grain)	100	80
Barley (straw)	100	99
Flax (grain	100	78
Flax (straw)	100	94
Potatoes (Green Mountain)	100	103
Corn	100	117
Sunflowers	100	116
Cabbage	100	100
Average	100	97

*For the purpose of comparison the yields on the unlimed plots are placed at 100.

Nitrogen.—In spite of the late date at which the land was broken the nitrogen in the peat became available rapidly enough for excellent yields, and in the case of most of the later maturing crops—late potatoes, corn, and sunflowers—the yields were as high with potash and phosphate as with an additional application of 200 pounds per acre of nitrate of soda. (See Pl. IV.) The other crops gave somewhat higher yields with the nitrate. The late breaking did not allow opportunity for much natural nitrification, and under such circumstances even the typical high-lime peats, which are characterized by the ready availability of their nitrogen, may be expected with early sown crops to show a response to nitrogen fertilizers.

The availability of the nitrogen in this bog during the first year, as well as its lack of response to liming, places the bog in the class of high-lime peats, and hence in later years sufficient available nitrogen for ordinary farm crops may be expected. The only crops whose yields would probably be increased by a

nitrogen fertilizer sufficiently to make this treatment profitable are such plants as lettuce and celery.

Potash.—The marked beneficial effect of potash applied alone is evident with all the crops except cabbage and clover hay. However, the yields were generally lower than where potash was accompanied by phosphate.

Phosphate.—The uselessness of phosphate alone is evident from both the tables and Plate IV. It even depressed the yields somewhat, but as soon as potash was applied the adequacy of the phosphate supply became evident. This depressing effect of acid phosphate when used alone on peat appears to be of very rare occurrence, but a similar instance has been reported from Michigan by Robinson[1] as follows:

> In the experiments made at the Michigan Experiment Station the plots to which acid phosphate was added always produced a slightly lower yield than unfertilized plots. This, however, is not the usual trend of work on this subject.

Amounts of Potash and Phosphate Required.—The chemical requirement of the peat is limited to potash and phosphate. Lime is useless and nitrogen is superfluous, except possibly for truck crops. Th experiment gives no indication as to how light the applications of phosphate and potash could be made and still obtain maximum yields, nor as to what quantities would be most profitable with various crops. The latter would depend somewhat upon the relative effect of different quantities of the potash and phosphate, but still more upon the cost of the fertilizers and the prices obtained for the crops.

The quantities applied in this experiment, purposely made heavy so that the maximum effect of each fertilizer might be shown, approximate those which European experience has indicated to be the most profitable for initial application on typical high-lime bogs owned by farmers. In this way during the second and later years he obtains the residual of the treatment during the first season.

The questions to be answered by the experiment related to

[1]Robinson, C. S. Utilization of muck lands: Mich. Agr. Exper. Sta. Bull. 273, p. 13, 1914.

the chemical requirements of the soil and not the most profitable application. The latter can now be readily determined by using varying quantities of the two fertilizers that have been found essential.

Summary and Conclusions.

An experiment was carried out in 1918 on the Forest Heights, Minn., bog, broken late the preceding autumn, on which clover, barley, flax, corn, sunflowers, potatoes, beets and cabbage were used as trial crops.

The soil, a typical peat from 1 foot to 5 feet deep, was of distinctly acid reaction and so low in lime, (approximately 1 percent), that its requirements of the mineral were doubtful.

The experiment showed the lime supply to be sufficient and the use of nitrogen fertilizers unnecessary, but that applications of both potash and phosphate were essential for maximum yields. Potash used alone was of marked benefit to most crops, but phosphate used alone was without effect or in some cases detrimental.

In the same season at Golden Valley, Minn., potash used alone did not materially affect the crop yield, whereas phosphate applied alone caused striking increases and gave as high yields as did its combination with potash.

PULVERIZED PEAT FUEL A SUCCESS[1].

By C. L. Bohannan,
Combustion Engineer.

History of Powdered Fuel.

It is surprising, considering the efforts made during the last fifteen years to increase the efficiency of all kinds of power plants, that until a comparatively very recent period progress in the economical combustion of pulverized fuel has been so slow. Almost a century ago pulverized coal was experimented with, but its first practical use was in 1895, when the Atlas Portland Cement Co. successfully burned powdered coal in their cement kilns. In 1896 the Manhattan Elevated Railroad Co. of New York tried pulverized coal on a locomotive, but owing to certain mechanical defects and the inability to pulverize the coal finely enough, this installation was not successful. In 1908 and 1909 the Carnegie Steel Co. experimented with pulverized coal on both boilers and metallurgical furnaces and, while fairly successful on the furnaces, the results on the boiler installation were classed as a failure. In 1912 the M. K. and T. Railroad Co. equipped their stationary boilers at Parsons, Kans., for burning pulverized fuel and operated with marked success. In 1920 powdered peat was successfully burned under a return tubular boiler at the Phoenix Building, Minneapolis, Minn. This was the first time powdered peat had been successfully burned in the United States, though the Swedish Government has produced like results for several years. In the United States at the present time powdered coal is being burned with marked success in cement making, copper roasting and smelting, iron and steel manufacturing, and for general power use.

Principles of Combustion.

The principles of combustion are, of course, generally known. The combustion of coal, as all know, is the chemical reaction of

[1]Abstract of paper read before Minnesota No. 8, N. A. S. E., Minneapolis, September 8, 1920. The author is with the Hennepin Powdered Fuel Co., Minneapolis, Minn.

the combustibles in the coal with the oxygen in the combustion air. If too little air is admitted, combustion must remain incomplete; in fact, it is nearly always impossible to obtain complete combustion for any length of time without excess air, as the mixture of fuel and air is rarely, if ever, sufficiently intimate to effect complete combustion, unless an excess of oxygen is present.

One of the primary causes for low boiler efficiency is low combustion temperature, which is caused by (1) incomplete combustion; (2) combustion with large excess of air; and (3) water vapor in the gas. Deficiencies of the boiler plant itself are also frequently the cause of low combustion temperature. It must be the aim of the boiler room engineer to get as near as possible to the theoretical combustion temperatures. If the combustion temperatures are right, the temperature of the waste gases will take care of themselves. It is an accepted rule that for any given quantity of fuel, the air temperature will always be in an inverse relation to the combustion temperature. This will show at once the importance of combustion with a low excess of air, as a large excess will not only increase the volume, but the temperature of the waste gas. This is, of course, only true if the other conditions of the boiler, as cracks in the setting, broken baffles, scale dust accumulations, etc., have been taken care of.

Value of Pulverized Fuel.

Having considered the essentials of combustion, we can now estimate the value of pulverized fuel. Grinding an inch cube of coal so finely that 85 per cent will pass a 200 mesh screen increases the surface exposure from six square inches to approximately 1,800 square inches, and thus increases the rapidity of combustion 300 fold. Having a finely divided fuel, it is possible to obtain a more intimate mixture of the fuel and air, which in itself reduces the amount of excess air required for complete combustion.

There have been three primary causes for the difficulty experienced in burning pulverized fuel successfully in boiler plants: (1) the lack of proper pulverizers for reducing the fuel to the necessary degree of fineness; (2) an inexpensive method for in-

timately mixing the dust and air; and (3), the velocity of the mixture entering the combustion chamber.

These problems were solved several years ago, after a great amount of experimental work, the main effort being to so shape the combustion chamber that complete combustion takes place before the unburned gases strike the shell or tubes of the boiler; that the velocity of the products of combustion is reduced to as low a point as possible and that at the highest temperature point they do not come in contact with the refractories of the combustion chamber. With pulverized fuel, as in oil and gas firing, we can, with the proper control of the air supply, both in the amount used to deliver the fuel and the regulation of the draft, shorten the flame propagation and have complete combustion within a few feet of the burner. This gives the hot gases better contact with the boiler and results in lower temperature of the waste gases.

A benefit derived from the use of pulverized fuel is the reduction in the cost of ash handling, this being reduced about 75 per cent over hand firing. The bulk of the ash settles out in the rear of the combustion chamber, where it can be easily removed through the cleaning doors. Part of the ash remains on the tubes, where it can be readily blown off and about 25 per cent of it is dissipated through the stack. This ash, however, being composed of such an impalpable powder, does not settle on the surrounding buildings. The Upson Bolt and Nut Co., located near Euclid Square, Cleveland, consumes about 100 tons of pulverized coal per twenty-four hours, this coal having an ash content of 10 per cent, and of this 25 per cent is never recovered. This installation has been in operation for over eighteen months and the smoke inspector of the City of Cleveland reports that he has never been able to find a trace of this ash, and that no large volume of smoke has ever been emitted from the stack.

Pulverized Peat Fuel.

The following gives a brief outline of the installation and method used for obtaining pulverized fuel. The fuel is dumped from the car into a reinforced concrete hopper, from which it is fed into a roll crusher by feeders that operate with variable speed motors so as to regulate the amount of coal being crushed with the number of pulverizers being operated. From this point

it is carried by a belt under a magnetic separator which removes any iron or steel that has become mixed with the fuel. The discharge of this belt is made into an elevator which in turn discharges to a screw conveyor and this to a crushed fuel bin. From this bin the fuel is carried by a belt to the dryers which have a capacity of 10 tons an hour when using fuel of a high moisture content. The dryer is of the indirect fired type to eliminate any danger of setting the fuel on fire. The firing of this dryer will be done by pulverized fuel. From the dryer the fuel goes to the pulverizers, which have a capacity of pulverizing 5 tons per hour, to a fineness of 95 per cent through a 100 mesh screen, and 85 per cent through a 200 mesh screen. Connected with the pulverizers are vacuum air separators. An air current carries the fuel to a series of collectors connected with a 50 ton pulverized fuel bin. This bin is so located that a five ton tank truck can drive underneath and be loaded with fuel by gravity. The truck will be equipped with a compressed air tank to facilitate the unloading of the fuel into the consumers' fuel storage tanks.

Feeding the Fuel.

The burning equipment for the individual boiler rooms will consist of the return line system. This consists of the pulverized fuel storage bin, which is placed, where convenient, in the regular coal bins and directly under the manhole to alley, or sidewalk, thus facilitating the discharge from tank wagon. It will be made of sufficient capacity to serve the boilers for 36 hours at maximum load requirements. The pulverized fuel is taken from the bin by a screw conveyor, driven by a variable speed motor through an iron pipe cross into the suction side of a high pressure blower. From this it is blown into the main header and distributed to the different boilers through branch pipes, the same as the gas or oil is taken from a header. This header coninues as a return line to a collector located on top of the pulverized fuel bin, returning any fuel not used at the boilers, where it is freed from the circulating air and falls into the storage bin to be used over again.

The air from the return line, after the fuel is eliminated, is returned to the suction side of the distributing blower. The ex-

cess air needed for combustion is furnished by a second pressure blower at a maximum pressure of 3 ounces. This air is mixed with the fuel and air from the primary blower through a Y connection, located from four to six feet from point of entrance to the boilers. The fire is controlled by the speed of the screw conveyor and a butterfly valve and baffle placed in the branch lines.

There are several distinct advantages of this system over the old system of using screw conveyors and hoppers for each unit, which may be summarized as follows:

1. The maintenance charges incidental to the old screw conveyors are eliminated.

2. Any number of units may be served, as several booster blowers can be used and the system carried on indefinitely.

3. Air distribution entirely eliminates the use of special hoppers and stoking equipment for each boiler.

4. The fuel is kept in continuous circulation, thus tending to prevent its caking and bridging over in the bin with the ultimate flushing in the screw conveyor when this breaks out.

5. When using peat as the fuel, no secondary air is required, thus further reducing the low cost of power required to furnish the fuel to the units.

Preparing the Peat.

The peat operations have now passed the experimental stage and we can expect a considerable amount of this fuel on the market by the fall of 1921. The work of excavating and air drying the peat has been done on a 60-acre tract, which is located three miles from the city limits of Minneapolis on Superior Boulevard. The peat on this bog averages about seven feet in depth and is not as high a grade of fuel peat as that found in the northern part of the State, where the depth is from 12 to 25 feet. This peat is much more compact and of an older formation.

The peat is excavated by a peat machine, which digs, macerates, spreads and cuts into briquets at one operation. This machine requires only one man to operate it and has a capacity of 100 tons of air-dried peat per day. After the peat is spread the crop is allowed to lay for about two weeks, exposed to the wind and sun, when it is piled into windrows by the use of an

ordinary road scraper for further air drying, and finally put into stock piles to await transportation to the pulverizing plant.

The dry pulverized peat contains about 3 per cent moisture, 10 per cent ash, 0.32 per cent sulphur and is capable of yielding from 9,000 to 10,000 B. t. u's. per pound.

Peat an Important Fuel Resource in Minnesota.

The experimental work of burning pulverized peat was conducted at the Phoenix Building, Minneapolis, with very satisfactory results. The actual comparison obtained by a weighed water test showed that about 10 per cent more peat was required to carry the same load than when burning pulverized coal.

Pulverized peat burns with a longer flame than pulverized coal, due to the high volatile content and lighter weight of the peat. A cubic foot of pulverized coal weighs 36 pounds, while a cubic foot of pulverized peat weighs 31 pounds. From the nature of the fuel, its high oxygen content, the quantity of air for combustion can be greatly reduced over that required for coal. A slight variation in the air supply will affect the furnace conditions with peat burning more than the same variation where coal is used. The ash is very light and does not stick to the tubes.

The Bureau of Mines, University of Minnesota, estimates that Minnesota contains seven billion tons of peat, the greater proportion of which is available for fuel. Therefore, Minnesota's fuel problem, which is becoming more acute each year, can be readily solved by the utilization of the peat beds of the State.

The burning of pulverized peat, while a new departure in this country, has been in successful operation in Sweden for several years. Results of tests by the Swedish government are summarized by Captain Ernst Wallagren, chief peat engineer of the Swedish government, who says:

> The peat powder, when burned by the method used at Back was equal in fuel value to the best English coal ton for ton. This discovery makes Sweden independent of other countries for fuel supplies for industrial uses.

Summary.

Summing up from these remarks, we have the absolute fact that the use of pulverized fuel produces a great saving in both

fuel and labor costs. For these conditions pulverized fuel gives us an ease of control that is as readily operated as a gas or oil fire.

In the United States 85 per cent of the power and heating plants do not run over 1,000 H. P. and the expense of a complete pulverizing plant has been prohibitive. This problem is now solved by the centralized pulverizing plant, delivering the pulverized fuel to the consumer in tank wagons. This is not in the experimental stage, as a coal company in Seattle, Wash., has built up a commercial business, particularly in connection with the use of pulverized coal for boiler plants and for power and heating purposes.

Tests of powdered peat show that Minnesota has a fuel of its own and is no longer necessarily dependent on the eastern coal fields for industrial fuel. Truly, the next decade should show a wonderful development of Minnesota's industries by Minnesota's own fuel—pulverized peat.—*Steam*, January, 1921.

NEWS OF THE DOMESTIC INDUSTRY.

General.

DEPARTMENT OF AGRICULTURE RECOMMENDS PEAT INVESTIGATION.

That there is a widespread interest in peat in this country is evident from an appropriation that was requested by the Department of Agriculture at the last session, but which, unfortunately, was not passed by Congress. The sum asked was $50,000 and it was to be expended for peat and muck land investigations. The request was the outgrowth of the continuous demand upon the department for definite and significant information regarding the agricultural usefulness of large areas of peat and muck, some of which are in process of reclamation, some of which have been drained but are not cultivated, and on some of which reclamation is contemplated. According to Dr. Taylor, of the Department of Agriculture, who testified before Congress on the subject, these lands occur to the extent of many millions of acres in the regions of our humid climate agriculture. The largest body that is in process of reclamation is in the Everglade district of Florida. There are 4,600,000 acres in Florida, 1,000,000 acres in Louisiana, and 12,000,000 acres in the 17 Northern States. Minnesota leads with 7,000,000 acres. These deposits differ radically in their agricultural character and represent at the present time the largest body of potentially useful lands for agriculture that are not generally known. Dr. Taylor further testified in detail as follows:

Within the category of muck soils belong some of the most productive soils that we have, soils which, with a balanced fertilization and suitable cropping, are extremely productive. The problem is one of large importance to our agriculture. It has had very thorough consideration by the department by an inter-bureau committee under the leadership of the Assistant Secretary, with a view to devising some practical way of getting the fundamental information that is lacking. It is a big activity and, when undertaken, should be pursued on a basis that will insure its being carried out. We are pressed for information. The ownership varies all the way from the State, through proprietorship by private owners down to individual 40 and 20 acre tracts.

Florida.

New Peat Company Formed.

It is understood that Mr. L. Parisot, of the Bartow chemical laboratory at Bartow, Fla., has been retained as official chemist for the American Humus & Phosphate Co., a concern with a 10,000 acre tract of peat in Polk County. According to this chemist the peat contains from 4 to 5 per cent of ammonia and is to be used commercially as a fertilizer. Although production has been in progress for only a few months, he states that there is a good demand for the peat from the fertilizer manufacturers.

Illinois.

New Humus Company.

Buyers of rough ammoniates will be interested in the completion of the Manito Chemical Company's plant at Manito, Ill. It is said to be located in the center of a bed containing over one million tons of humus.

Their product is black, completely decomposed, and non-fibrous, and has a guaranteed ammonia content of 3½ per cent. The material is screened and ground and dried to a moisture content of from 12 to 14 per cent.

The factory is situated on the Chicago, Peoria and St. Louis Railroad, and the offices are located in the Lehmann Building, Peoria, Ill. The company is capitalized for $150,000. The following are the officers: William E. Hull, president; Walter W. Furey, treasurer; T. E. Bradley, secretary; and Leslie H. Erler, general manager.—*American Fertilizer*, March 26, 1921.

Massachusetts.

Field Claims Discovery of New Nitrifying Process.

Mr. Bernard Field, of Plymouth, Mass., has recently reported the results of experiments by which he claims the yields of certain plants have been considerably increased by the use of bacteria in combination with peat. The product is called "dex-

trogerm" and the International Products Corporation, 132 Boylston St., Boston, Mass., are the manufacturers and distributors.

Minnesota.

Several Cities Plan to Use Peat Fuel.

The possibility of using powdered peat for fuel in Duluth was given consideration at recent meetings of the Commercial Club and much interest was shown in the project. Mr. Pears, secretary-treasurer of a Minnesota peat company, declared that pulverized peat had proved successful in heating office buildings in Minneapolis, and that there was a large quantity in St. Louis County which could be supplied to Duluth. He said that powdered peat was equal in heating value to powdered coal and that the cost of the peat would not exceed one-half the price of coal. It was proposed to install a plant in Duluth capable of producing 480 tons per day.

At a weekly luncheon of the Eleveth Rotary Club, Mr. J. H. Lomen, President of the Biwabik Commercial Club, addressed members on the development of the peat bogs of Minnesota for fuel. He described in detail the machine that is now in use t Biwabik for making briquettes.

Legislature Appropriates $20.000,

In view of the widespread interest and possibilities of peat an appropriation of $10,000 a year for two years, was made at the last session of the State legislature to provide for experiments. The text of the law is as follows:

For experimentation and investigation of the methods and uses of peat as a source of fuel for heating, power and metallurgical purposes, and for other like uses * * * $10,000 for the fiscal year ending June 30, 1922, and $10,000 for the fiscal year ending June 30, 1923. The experiments and investigations are to be carried on under the direction and supervision of the University of Minnesota.

While the bill was pending Mr. F. A. Wildes, Superintendent of the State Bureau of Mines, arranged for the installation of peat burning apparatus in the power plant of the State Capitol Building at St. Paul, and demonstrated the possibilities of peat before the members of the legislature. The equipment was in-

stalled by the Hennepin Atomized Fuel Co., which has a plant in Minneapolis. Mr. Wildes stated that the success of powdered peat as fuel had been proven and that it was fed into the furnace under a slight air pressure and burned like gas.

Professor Peter Christiansen, of the School of Mines, University of Minnesota, said in a recent statement for the press:

The burning of peat has a national significance. There are relatively few farmers in Minnesota, except in the southeastern, western and extreme northwestern portions, who could not make themselves independent of coal by using peat from their own or nearby farms.

New York.

Enricht Makes Unique Claim for Peat.

Gasoline at 15 cents a gallon is the plan of Louis E. Enricht, of Farmingdale, N. Y. He has filed patents at Washington protecting him in the manufacture of gasoline from peat and has begun preparations for the formation of a company.

Enricht has made crude experiments in his laboratory with a small apparatus. He says that one ton of air-dried peat will make about 100 to 108 gallons of peat gasoline, about two gallons of wood alcohol, and three pounds of acetone as a by-product.

The Farmingdale inventor alleges that he produces gasoline by putting the peat through destructive distillation under pressure, and that the gases obtained are liquefied by a catalytic process under high pressure.

Wisconsin.

Appleton Peat Products Co. Said to be Operating.

According to the press the Appleton Peat Products Co., of Appleton, Wis., has reached the operating stage. The plant, which was designed by C. A. Willmarth, is located at Center Swamp, five miles north of the town, and is said to be producing fertilizer and fuel. The deposit was examined by Dr. R. M. Bagg, professor of geology in Lawrence College, who reported that the swamp contained 400 acres of peat ranging from 3 to 14 feet in depth. The following men are the officers: S. W. Murphy, president; C. A. Willmarth, vice-president and general manager; C. C. Nelson, secretary; and J. P. Frank, treasurer.

NEWS OF THE INDUSTRY IN FOREIGN COUNTRIES.

Finland.

A New Process of Drying Turf for Fuel in Finland.

Consul Leslie A. Davis, of Helsingfors, reports that a Finnish company, called Oy. Hydroturve A. B., has been formed, with a capital of 1,000,000 marks, for the purpose of promoting the hydroturf process of drying turf to relieve the serious fuel shortage in Finland. Similar companies have been organized in Sweden and Denmark.

The new method was invented by engineers working under orders from the Russian Soviet Government to find a labor saving method of preparing turf as fuel for the great central power station near Moscow, the process being made known in Finland through a Russian Engineer.

The fundamental principle of the process is quite simple. The raw turf in the swamp, by a powerful jet of water under a pressure of 20 atmospheres, is freed from all old roots and changed to thin mud. This is pumped out on a drying field and spread in layers from 20 to 30 cm. in depth. When sufficiently dry it is cut into bricks of uniform size by means of a tractor. The roots are lifted out of the mud by a special crane without interfering with the removal of turf. The turf pump is constructed like an ordinary water turbine, is reversible with aid of an electric motor, is equipped with a cutting apparatus which completes the work of the water jet, and can be raised or lowered as the surface of the mud requires. Both the crane and the pump are mounted on a plate-covered car which can be pushed backward or forward on rails along the line of work.

Experiments in Russia demonstrated that the hydroturf dries better in ordinary weather than turf prepared in any other way. —*Chemical and Metallurgical Engineering*, February 2, 1921.

Russia.

Importance of Peat Industry Increasing.

The output of peat in Russia in 1919 was 67,000,000 poods. There were 57,910 persons engaged in the production and each produced 1,155 poods. On account of the difficult conditions

encountered in the industry the workers received higher rations than many other laborers. One pood of food was given out for each 350 poods of peat.

It is said that the inventions of Classon and Kirpichnikoff relating to the hydraulic method of peat production will greatly increase the importance of the industry. The method consists of directing a strong current of water upon the peat and thus turning it into a paste. A special suction pump is then applied which spreads the paste through pipes over the drying ground in a layer about 3 inches thick. Before the mass has completely dried it is traversed by a specially designed car that moves on two wheels equipped with rims on which briquette-shaped molds are mounted. A special method is used for the final drying process. The method of sun-drying devised by the engineers mentioned is said to effect a saving of 8 to 10 per cent in labor. The general methods of producing peat are steadily improving.

It is reported that some of the central electric power stations which the Government plans to use in operating the railroads will be operated with peat fuel.

Sweden.

Powdered Peat a Commercial Success.

Tests extending over several months have passed the experimental stage and conclusively demonstrated that peat, reduced to powder or prepared in the form of briquettes, makes an excellent substitute for coal as fuel for locomotives. The Railway board of Sweden, satisfied with the results of these long-continued tests on the State railroads, has recently taken over the specially constructed plant at a bog near Vislanda, with a capacity of 30,000 tons per annum. The machinery employed is well adapted for the purpose of converting peat into a cheap and effective fuel with a small working force. The peat is dried in the open air as far as possible. Only the hardest and driest lumps are used for ordinary fuel, the remainder being converted into powder or briquettes. The plant was originally intended for the manufacture of peat powder, but it was found that briquettes were as well adapted for fuel, hence both are now being made. The discovery was also made that powdered peat becomes a dangerous explosive when subjected to high temperature.

TILE DRAINAGE ON PEAT LANDS.[1]

By E. R. Jones.
Wisconsin State Drainage Engineer.

General Statement.

Wisconsin has thirty inches of rain each year. It makes some of our lands wet, but we are draining them, and we are glad it is not necessary to irrigate.

One of the best farmers in Dodge County once argued that the wet areas in his field raised just as much oats as the drained areas. For many years he had counted the bushels that came from the separator, but he had never compared the yield of the wet areas with the dry. In 1908, at the suggestion of a khaki-shirted college professor, he stripped the heads from the oats that grew on a square yard in his wet area and measured them. Then he selected a square yard of well drained land, but he had stripped the heads from only a square foot of it when he had a quantity of oats equal to that yielded by the square yard of wet land. The next year he laid some tile drains and he has never regretted it.

It is land just dry enough to tempt cultivation, but so wet that it yields only one-eighth of a crop that subjects the farmer to the greatest loss. The wetter areas are so poorly drained that our farmers know better than to try to cultivate them until the excess moisture has been removed.

Value of Tile Drains.

Some of the most difficult pieces of land to drain have the most successful drainage systems. The farmers themselves try the jobs that look easy, and sometimes blunder. The projects that appear hard are usually turned over to an engineer who recognizes the difficulty, meets it, and installs a successful drainage system.

I have seen forty rods of five inch tile laid in a wet swale save eighty bushels of corn in a single season. It makes no

[1]Delivered at the Fourteenth Annual Convention of the American Peat Society, Madison, Wis., September 2, 1920.

difference whether the total cost of the tile and labor was a dollar a rod, and the corn worth fifty cents a bushel, or whether it costs two dollars a rod and the corn was worth one dollar a bushel, the profit on the tiling is 1,667 per cent. I figure it this way, taking the higher scale of figures. The forty rods of tile cost $80.00. At 6 per cent the interest on this investment is only $4.80 a year, yet it saved $80.00 a year. In other words, the saving is 16 2-3 times as much as the interest on the investment that caused the saving. Moreover, it was easier to cultivate the dry acre than the wet one.

Drainage Laws.

Every drain must have an outlet. No drain is any better than its outlet. Wisconsin has two good drainage laws governing community outlets, the drainage district law and the farm drainage law. The latter is commonly called the county drain law. The two laws can be summed up in the commandment, "Thou shalt join hands with thy neighbor in constructing an outlet that will do thee both good, and for its construction thee and thy neighbor shall each pay his just share."

Our drainage laws provide for irrigation where such is necessary. Time was when a certain old cranberry grower turned all the waste water from his marsh into his son-in-law's reservoir, and the only advice I could give to another young cranberry grower who wanted some of this water was that he had better marry the old fellow's other daughter in order to get half of the water. Today our laws render such alliances unnecessary. I believe we have cut out much of the red tape and obstructive technicalities from our drainage laws. Cooperation is the keynote between neighbor, farmer, banker, land owner, agricultural college, and State Department of Engineering.

Drainage Problems.

Of Wisconsin's 7,000,000 acres of wet lands, 2,000,000 are beds of peat from 3 to 15 feet in depth. About half a million of these peat acres have been provided with outlet drains by the 80 drainage districts that have been organized. About four-fifths of this land is partly drained, but awaits the complete

drainage that tile will afford. It is in that intermedate stage best described by Mark Twain when he referred to the waters of the Missouri River as being a little too thin to plow and a little too thick to drink. It is in the intermedate stage that has drainage enough to kill the wild grass but not enough to make it possible to raise tame grass; dry enough to ruin the peat by burning, but too wet to permit the surface and fence corners to be kept free from inflammable grass and weeds that invite fire; and ditches enough to cause floods, yet not enough drainage to give the soil the absorbing power to prevent floods. We have 400,000 acres of peat in Wisconsin in this lamentable condition. The other fifth, or about 100,000 acres, has been tiled and most of it successfully. Some failures have occurred, of course, due to poor workmanship.

Extent of Damage.

In peat, as in clay, you can not drain the soil too much. After the drain tile has ceased to drip there is still left in the soil all the capillary water the soil can hold or the plant can use. Not among all of the forces of nature is there a better self-regulator than capillarity. It fixes the limit up to which drainage is necessary and beyond which it is impossible.

Crops do not like excessive moisture. With the water as stagnant as it is on most marshes, they do not send their roots much below the water table. With sufficient drainage, corn and other plants send their roots down to a depth of more than three feet. The proper level of the water table in soil, whether peat or not, is three feet or more below the surface. With shallow drainage during the spring a shallow root system develops. This handicaps the plant during the drouth that may come later in the season. By deep drainage during the spring we are encouraging a deep root development which will enable the plant to stand the drouth of July.

In some cases it is possible to let the drainage system operate during April and May, and perhaps June, and during July to close the outlets and hold the water for sub-irrigation. The success of sub-irrigation depends upon the amount of seepage entering the soil from higher lands. Generally this seepage is so reduced during a drouth that it is not enough to supply the

needs of parched crops. Nevertheless, these crops are better off because of the fact that they have had deep drainage during the spring when their root system was forming.

Essential Features.

There are three essential features to every successful drainage system: (1) There must be an outlet in the main water course; (2) the seepage entering from higher lands must be cut off and carried to the outlet before it wets the land to be drained; and (3) there must be a sufficient number of internal drains to draw off the damaging water that enters in spite of the protecting drains. In many cases no internal drains are necessary if the seepage has been cut off effectively.

The drains must be deeper than three feet if the water table is to be kept three feet or more below the surface in all places. The water table midway between two drains four feet deep and four rods apart may be only two feet below the surface. If the drains were only three feet deep, it would be only one foot below the surface midway between the drains. On the university marsh we had to place the lines of tile two rods apart where our tile could be laid only three feet deep. The deeper the tile are set the farther apart they may be placed with good results. Furthermore, deep drainage, particularly tiling, is advisable in a peat soil to provide for the shrinkage and settling that takes place in the peat above the tile. On one marsh we found that four feet of peat shrank 0.8 foot in about six years. Much of the tile laid down three feet deep in a peat soil will be within reach of the plow within five years. This is partly due to the shrinkage of the peat and partly to the heaving of the tile with freezing. If there is any place where tile should be below the frost line, it is in a peat soil, because the high water-holding capacity makes it heave a great deal upon freezing.

Tile drains are better and cheaper than open ditches. To be five feet deep an open ditch must be from six to ten feet wide at the top, even in peat. The cost of moving this large volume of soil is greater than that of the tile drains, which can be placed in a narrow trench. Furthermore, an open ditch has to be cleaned out almost annually. Properly laid tile drains are self-cleaning. The waste of land caused by open ditches is such that

they should be tolerated only where it is impossible to get tile, or where the fall is so limited that it is not possible to lay the tile 3 feet deep with the descending gradient of one in 1,000 to a free outlet.

We have advised farmers to dig narrow trenches, bury tamarack poles in them, and cover them up, rather than to permit ditches to remain open. Old drains of this kind have given good service for ten years. In timbered land where poles are plentiful they have aided many of our farmers to solve their problems.

Capstan ditches have been disappointing to many of our farmers. These ditches are made by a large plow pulled by a capstan connected by means of a long cable. The ditches are about three feet deep, one foot wide at the bottom, and seven feet wide at the top. Their depth cannot be controlled. They cannot be dug deep enough in the high places to drain the low places at all. On many of our marshes there is a ridge of glacial material near the outlet. The capstan plow invariably fails to dig a ditch through these ridges deep enough to empty the ditches on the marsh. Where hand work is used to deepen the ditch in the high places, the workmanship is usually such that the ditch caves in about as soon as the contractor gets his pay. Such feeble attempts at drainage are discouraging and misleading. Farmers blame the marshes when they should blame themselves for putting in such poor drains. Capstan ditches appeal to some farmers because they can be installed quickly, often as much as a half mile a day. The farmer is usually happy for that day and sorry for the rest of his life. They cost $2.50 a rod.

Capstan ditches do not improve marshes for subsequent tiling as much as commonly supposed. With such shallow drainage the marshes settle but little, and that within a few feet of the ditch. The ditches have no value at all as a trench for the tile. A tiler would prefer to dig a new trench 5 feet deep at the side of a capstan ditch that has been in a year or more than he would to dig a similar grade below the bottom of the old ditch. The only exception to this is land that is full of fibrous roots.

As makeshift outlets capstan ditches are tolerable. By that we mean a shallow outlet across a flat marsh that is but little higher than the lake or river which forms an outlet. By digging

such a ditch with a level bottom upon reaching higher marsh a depth of perhaps four feet may be gained. This is deep enough to serve as an outlet for tile. When the lake or river is lowered, a large tile may be used in place of the capstan ditch.

Some marshes raise good crops with only shallow ditches 8 or 10 rods apart. In those places a line of 5 inch tile laid as deep as the open ditches would do the same work at about the same cost, and the tile would last longer. Even though tile can be laid only 3 feet deep because of a shallow outlet and must be re-layed in ten years, the work of re-laying the tile is less than that of cleaning the open ditch each year.

Open ditches have no advantage over tile in a peat soil. By drawing water, even at a slow rate 24 hours a day, the tile will keep the peat dry enough to absorb and hence dispose of as much surface water as an open ditch would carry. There is no peat soil that will not permit at least a little water to flow through it into tile the first year the tile are laid. The efficiency of the tile increases as changes take place in the collulose found in raw peats. Even when it is moving at a slow rate into tile it is moving as fast as it would into an open ditch through the same soil at the same depth, because it has the same path to travel regardless of its ultimate outlet.

By deep peat we mean peat that is five feet or more in depth. In such peat we try to have laterals averaging 5 feet in depth. They are generally required at intervals of 8 rods. In order to accommodate a line of tile 5 feet deep at a low point in a marsh 80 rods away from an outlet ditch with a fall of 1 foot per 1,000, such open ditch must be at least 9 feet deep on most peat marshes. We believe that a ditch 3 feet wide at the bottom and 6 feet wide at the top is the smallest permissible under normal conditions.

It is safe to lay tile in a peat marsh the first year after the outlet ditch or tile is constructed. We have done it successfully. The next best thing is to dig trenches a foot wide, 18 inches deep and 8 rods apart where partial drainage is desired. This costs not more than 50 cents a rod, even where fibrous roots have to be cut at the side of the trench. These trenches render service for a year without filling up. The next year they may be made 4½ feet deep and graded for tile.

Mistakes have been made in expecting that deep outlet

ditches would complete the drainage. In some cases where the seepage has been effectively cut off at the edge of the marsh by lines of tile discharging eventually into the outlet ditch, it has been possible to raise timothy and alfalfa on raw peats. This makes good hay and a hay crop is a profitable one where areas of marsh land are handled on a large scale. The small farmer, however, wants to raise corn on his marsh land if he is in the corn belt, and to do that additional lines of tile are necessary. If the marsh is uneven in character, the distribution of lines of tile over the area should be made to vary in accordance with conditions. There may be places where the tile should be 4 rods apart. In other places they may be 20.

Ten rods of tile costing approximately $20.00 an acre is a small investment when compared with increased yields. The cost at 6 per cent amounts to $1.20 a year. This is less than a bushel of corn. Ten rods of tile to the acre frequently means the saving of 50 bushels of corn.

If the peat is 3 or 4 feet deep and underlain by clay the tile should be placed one-half foot into the sub-soil, but if underlain by sand, one foot. If the peat is less than 3 feet deep the tile should be put down at least 3 feet deep regardless of subsoil.

The tile itself does not settle even where laid only 5 feet deep in a bed of peat 10 feet deep, provided seepage is so limited that the water table sinks below the tile during a period of drouth. This introduces air into the soil below the tile and permits decomposition that results in the settling of the tile. As a precauton it is well to have the main tile where the peat is deepest and the heads of the laterals where the peat is shallowest. Any settling of the grade line that may result in such cases tends to increase the gradient of the lateral and thus counteracts the greatest danger that may come from a settling of the tile. Nothing smaller than 5 inch tile should be used in a peat soil.

In cattail marshes soft pockets of peat are sometimes found below the grade line of the tile. Here two poles should be used in the bottom of the trench to form a trough between which the tile may be placed.

Peat marshes in which old stumps are imbedded can be equipped with tiles only with diffculty. However, it is easier to dig a narrow trench into such a soil for tile than to dig it wide enough for an open ditch. In such places ditching by

dynamite has advantages. If tile are laid the liberal use of the broad axe to cut the roots encountered is necessary.

It is unsafe to tile or ditch a peat marsh unless the subsequent management provides for keeping all grass mowed in the fence corners, and for keeping all other dry rubbish from the surface where it will invite a fire during the dry part of the year and cause the peat to burn. This is but another way of saying that until the farmer is in a position to make good use of his peat, he had better postpone even starting to drain it.

SOIL SURVEYS.

Pierce County, Georgia.

By E. T. Maxon,
United States Department of Agriculture.

Swamp.

Swamp is the term applied to alluvial areas which are wet most of the year and are subject to frequent overflow. The soil material varies from light to dark in color, and from a fine to medium sand.

Swamp is found to some extent along all the stream courses of the county. The largest areas wholly within the county are found in the eastern and southern parts in the vicinity of Zero Bay, Cross Swamp, Rawlerson Swamp, and Little Okefenokee Swamp, and along the Alabaha and Satilla Rivers. These areas support a growth of cypress, bay, slash pine, and ash, with a dense undergrowth of huckleberry, myrtle, bamboo, and water-loving grasses. Most of the virgin timber has been cut off.

The Okefenokee Swamp, which comes into one corner of the county, consists of an irregular shaped area with a thick fringe of undergrowth, slash pine, and cypress along the edge and an open, prairielike area, covered with water, and filled with aquatic vegetation beyond.. Small islands are scattered throughout this prairie.

On account of its low position and liability to frequent overflows, swamp has no agricultural value in its present condition, and could be made suitable for crop production only by a very expensive system of ditches and levees. It is probably best suited for forestry, but care must be taken to prevent the disastrous fires overrunning the areas each year.

Millville Area, New Jersey.

By C. C. Engle and Others,
United States Department of Agriculture.

Swamp.

The soil classed as swamp occupies low, wet areas along

streams and broad, wet flats about stream heads. The soil is highly variable. It consists chiefly of black, mucky sand, loamy sand, sandy loam, or loam, 2 to 3 feet deep, overlying white or yellowish sand or dark-brown sand or sandy loam. This material was mapped as Hyde loamy sand in the Camden area, but because of its highly variable nature it is classed as swamp in this survey. Occasionally the swamp areas are full of small islands. This is particularly true of Bear Swamp between Cedarville and Dividing Creek. These islands are elevated 2 to 3 feet above the general surface and consist of Portsmouth sand and sandy loam, Elkton loam (in Bear Swamp), and Norfolk sandy loam, poorly drained phase. The soil in Bear Swamp is not very wet except in rainy seasons, and the growth is largely beech. Of less importance are Carolina red maple, sweet gum, sour gum, white cedar, and holly. The most valuable of the areas of swamp are the "cedar swamps" or "cedar brakes," in which the most striking growth is white cedar. Good cedar-swamp areas bring $200 to $400 an acre for the timber. Other species occurring in abundance are sweet bay or swamp magnolia, Carolina red maple, sweet pepperbush, sour gum, and marsh alder. Among the smaller plants blueberry, sumac, azalea, and ferns are abundant. In addition there are many grasses, mosses, rushes, and sedges.

Swamp is one of the most extensive types mapped in the Millville area, but it is of little agricultural importance. It is used only for the production of cranberries, a small acreage having been drained and diked and converted into cranberry bogs.

Chenango County, New York.

By David D. Long,
United States Department of Agriculture.

Muck.

Muck differs markedly from other soils in being composed largely of decayed and decaying vegetable matter. Where the vegetable remains are still in a fibrous or only partially decomposed condition, so that they still retain their original structure and the material has a brown color, it is properly classed as

peat; while areas in which decomposition has advanced to such an extent that the fibrous nature is largely destroyed, resulting in a black, spongy mass, are classed as muck. In Chenango County most of the areas mapped as muck are really a peaty muck, in that the surface layer is well decomposed while the lower stratum is still fibrous. Typical muck is more generally found in this county in the shallower deposits.

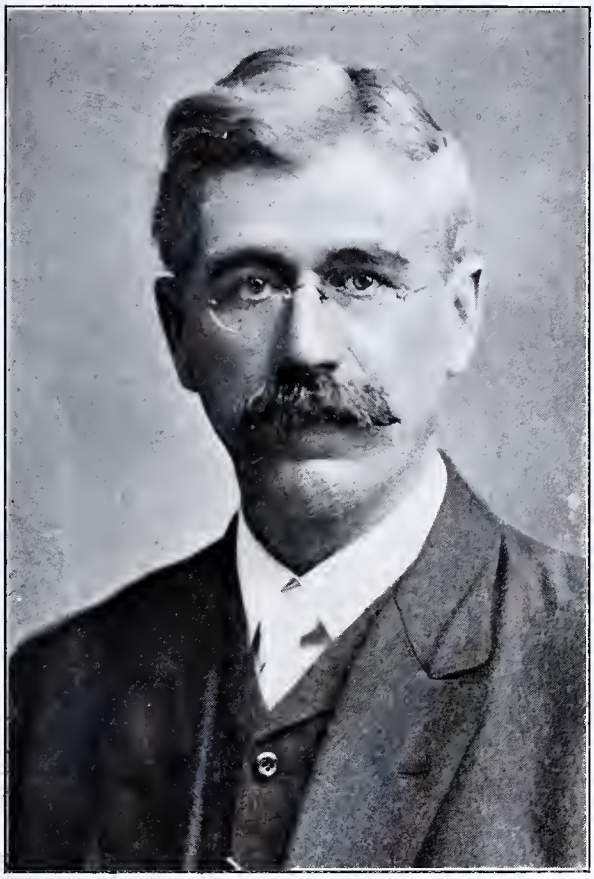
The depth of the deposits varies from a few inches to several feet. Over most areas the depth is 2 or 3 feet, or even more, and much of the muck is several feet in depth. The underlying material varies from sand or clay to glacial till.

The surface of the muck areas is flat, and the material is usually saturated with water throughout most of the year. artificial drainage is always necessary before the type can be used for agriculture.

There are only a few scattered areas of muck in Chenango County. The largest lie in the towns of Preston, Plymouth and McDonough. Smaller areas are scattered throughout the uplands and along the wider valleys.

Most of the type supports a growth of hemlock, elm, ash, tamarack, and swamp maple, with an undergrowth of rushes, marsh grass, and flags. A few areas have been cleared and produce coarse forage or afford some pasturage. None of the muck is now cultivated. When drained and otherwise reclaimed this is a very valuable soil, particularly for special crops such as celery and onions. It can also be used for general farming, as it is capable of producing good yields of corn, buckwheat, potatoes, and other crops.

PIONEERS OF THE INDUSTRY.



Robert Ranson, of St. Augustine, Fla., student and producer of peat products since 1900 and charter member and vice president of the society for many years.

Mr. Ranson was born in 1859 at Suffolk, England, and was educated at the King's Grammar School, Norwich, England, and Moravian College, Prussia. He is a member of the American Association of Engineers and an Associate Member of the Royal Sanitary Institute of London and has thoroughly investigated the peat deposits of the United States and many foreign countries.

PROCEEDINGS OF THE EXECUTIVE COMMITTEE.

By Chas. Knap.

A special meeting of the Executive Committee called at the request of two members, was held at 1134 Broadway, New York City, on February 10. The following members were present:

John N. Hoff, Chairman,
Myron W. Robinson,
G. Herbert Condict.
Chas. Knap.

Plans Made to Increase Membership.

The meeting was opened by a general discussion relating to the most effective method of enlarging the usefulness and membership of the society by the publication of bulletins on peat in the newspapers of cities adjacent to the deposits. Mr. Robinson offered to bear the expense of the distribution of a bulletin prepared by Mr. Osbon outlining the general nature of peat and pointing out its commercial significance to the communities where it occurs. The committee accepted the offer with thanks.

Mr. Hoff then stated that if Mr. Robinson's efforts to have the bulletin printed as a news item proved successful he would personally defray the cost of circulating a similar bulletin presenting the value of peat as a fertilizer ingredient and crop soil. Mr. Hoff's offer was also accepted.

To further augment the membership the secretary was instructed to send circular letters outlining the scope and purposes of the society to prominent members of the National Farm Bureau Federation, Boards of Trade, Commercial Clubs, and other organizations in the peat regions.

Next Convention Considered.

The secretary was further instructed to request the views of absent officers with regard to the next convention. Florida and New York were tentatively suggested as meeting places and the secretary was directed to communicate with the Florida

State Board of Agriculture to ascertain whether co-operation might be expected if that State were selected.

Campaign to Lower Freight Rates Considered.

The high freight rates on peat shipped as fertilizer and fuel were then considered. It was pointed out that, because of the excessive cost of transportation, the growth of the peat industry was being retarded to the detriment of the public. The secretary was instructed to write to the freight agents of the trunk lines for the purpose of arranging a conference with the executive committee with a view to having a freight rate established for peat shipped as fuel upon the same basis as coal, and peat shipped for fertilizer upon the same classification as manure.

There being no further business, the meeting was adjourned.

Advance Publication of Government Data Authorized.

Pursuant to conclusions reached in previous meetings, the officers of the executive committee have communicated further with the Geological Survey and obtained permission to publish extracts from the manuscript of a report on the Occurrence and Uses of Peat in the United States by E. K. Soper and C. C. Osbon. The complete report is the most exhaustive treatise on peat that has been prepared in the United States and could not be published in large part without greatly increasing the size of the journal. It is proposed to publish an excerpt on the peat deposits of Michigan in the October journal. The survey itself will probably undertake publication during the fiscal year beginning July 1 and it is doubtful whether further extracts will appear in the journal prior to the official publication. The excerpt relating to Michigan was selected because there is no detailed information available concerning the quantity and quality of the peat in that State.

Since the meeting on February 10 correspondence has also been conducted and conferences held with the railroad officials with a view to securing a reduction in freight rates on peat. Announcement of the results will be made in an early number of this journal.

Meeting Place for Next Convention Decided.

The executive committee again met in New York on May 23 and after careful deliberation voted to hold the fifteenth annual convention at the Hotel Commodore in New York City on September 7, 8, and 9.

ABSTRACTS OF PATENTS.

Coking Peat.

By Drs. Pohl and von Detwitz.

In the coking of raw peat, the heating takes place alternately under pressure and vacuum. The peat is charged into a cylindrical container having heating-tubes extending through it for passage of super-heated steam or electrical heating-means, the temperature of each individual tube and the peat zone around it being independently regulated. Discharge pipes are connected to various temperature zones. Raw peat is heated more strongly in the lower zone than in the upper, part of the water content being converted into steam, increasing the pressure from 6 to 8 atmospheres. The steam discharge pipe is opened in the lower zone causing a fall of pressure whereby a part of the moisture not converted into steam is withdrawn; this process is then repeated until the desired moisture content has been reached, the temperature not rising above 200 degres C. When a moisture content of say 30 per cent is reached, other heating elements can be used and the entire mass heated uniformly at increased temperature to effect coking proper, and this may be done *in vacuo* or under pressure.—British Patent 158,513.

Peat Cutting Machines.

By T. Tomlinson.

A machine for cutting peat comprises an endless chain passing over pulleys to form a track for the vehicle, and carrying a series of blades which penetrate and divide the peat. The pulleys are driven in either direction by an electric motor, and the cutters may be preceded by disk cutters and are followed by a horizontal cutter. The cutters can be moved into or out of operation according to the direction of travel of the machine. The cut peat is carried up by a conveyer and delivered to a transverse conveyer. If a number of cutters are employed the corresponding conveyers and the conveyer may be operated at such speeds that the cut peat is delivered without interference. The conveyer may be adjustable in position across the machine,

and a belt-tightening pulley may be fitted. According to the Provisional Specification, a wheel having a cutting rim and transverse cutters may be employed, and may be carred by a truck running on rails.—British Patent 153,683.

Peat Fuel Producer.

By J. Bobst Et Fils, S. A.

An apparatus for extracting and kneading peat comprises a carriage traveling on rails and carrying a vertical turf-cutting spade and extraction basket, a screw conveyor for conveying the extracted peat to a reservoir, a screw conveyor for conveying the peat from the reservoir to a kneader, and a conveying means with small movable boards or plates for discharging the kneaded lumps of peat. When the peat-extracting apparatus has delivered the contents of the basket into the conveyer, it is moved forward through a distance equal to the width of the basket. An automatically-acting apparatus causes the advance of the kneader and the charging-apparatns mounted on connected carriages. This automatically-acting apparatus includes a removable stop which bears, under the action of a counterweight and rocking-lever against one side of the conveyer; the stop is placed in a seating or a seating in a sliding-rod connected to the lever, the seating being selected according to the direction in which the carriage is to travel. The movement of the kneader carriage is controlled by means of a coupling-mechanism actuated indirectly by the action of the counterweight on one end of the rocking-lever. The reservoir is fitted with beaters, which cut up the peat and force it towards the inlet to the conveyer. After kneading, the peat passes through a screw plate and the resulting lumps are deposited on the movable small boards or plates.—British Patent 155,275.

Plant For Producing Peat Gas.

By L'Alliance Royale Industrielle.

A plant for producing peat gas, comprising a retort for furnacing the peat, having outlets at the upper end and inlets at the lower end, a pipe from one of said outlets leading to the innermost one of a plurality of widening circles from which

the pipe extends to the innermost one of a plurality of widening circles of smaller dimensions than the aforesaid widening circles, producing a number of substantially circular streams of gas, a scrubber connected to the last-named arrangement of pipes and a cooler, and a pipe from the second outlet connected to the outside pipe of the larger set of circular stream pipes, a deposit receptacle connected to each of the circular streams of gas and connected to the retort by return pipes, an oil supply tank connected to a deposit receptacle and an air supply tank connected to the second set of circular streams.—Canadian Patent, 209,741.

Production of Gas from Peat.

By Le Combustible National, Ltd.

A process for producing gas from peat, comprising furnacing the peat, drawing the gas and causing it to flow in gradually widening circles and draining it of its deposits from each circle of flow and returning the deposits to be refurnaced and drawing the gas from the outer of said widening circles and causing it to flow in another arrangement of widening circles, and draining the second arrangement of circles of the deposits from the gas and returning said deposits to be refurnaced and drawing the gas from the outer one of the second set of circular streams to a scrubber and cooler.—Canadian Patent 209,979.

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PROCEEDINGS OF THE FIFTEENTH ANNUAL CONVENTION.

New York Meeting Interesting and Instructive.

The Fifteenth Annual Convention of the American Peat Society held at the Hotel Commodore in New York City on September 7, 8 and 9 was one of the most interesting and instructive meetings in the history of the society. Although the attendance was small, this handicap was more than offset by the quality of the papers presented and the discussions that followed. All who attended were much interested in the scientific aspects of peat outlined in the papers and greatly encouraged by the progress of the industry and related discoveries during the past year. Credit is largely due to Charles Knap, Secretary-Treasurer, for the arrangement of the progam.

Many Interesting Papers Presented.

The following is an abstact of the proceedings:

Wednesday, September 7, 1921.

The convention was called to order at 10:30 a. m., by Secretary Knap. Mr. Myron W. Robinson, of the Crex Carpet Co., Second Vice-President, delivered the address of welcome. The following papers were read during the morning session:

"False Promotion and Inefficient Engineering in the Peat Industry," by Robert Ranson.

"Commercial Briquettes from Peat," by Albert L. Stillman.

An interesting discussion succeeded, which continued until lunch.

The meeting re-convened at 2:30 o'clock and the following papers were read:

"Commercial Production of Sulphate of Ammonia from Peat," by B. F. Haanel.

"Commercial Production and Utilization of Air-Dried Machine Peat Fuel," by Ernest V. Moore.

"The Use of Powdered Peat for Industrial Fuel," by C. C. Osbon.

At the close of the interesting informal discussion elicited by these papers the meeting adjourned for the day.

Thursday, September 8, 1921.

During the morning session the following papers were presented:

"Recent Progress in the Cultivation of Peat Soils," by Professor H. C. Thompson.

"Sweet Corn as a Muck Crop," by Professor James H. Beattie.

"Application of Bacteriology to Soil Fertilization," by G. H. Earp-Thomas.

At noon an informal luncheon was served in the convention hall.

At the afternoon session the officers and members of the executive committee whose names appear on one of the preceding pages of this journal were elected for the ensuing year, the secretary-treasurer's report was read, and the constitution was amended to conform to postal regulations.

Friday, September 9, 1921.

On Friday, September 9, several members and other interested persons took advantage of the opportunity that was given

them to visit the truck farms and humus plant of John N. Hoff, of the Alphano Humus Co., at Great Meadows, N. J. Mr. Hoff personally conducted the party over the properties in automobiles and on the humus company's narrow gauge railroad, and demonstrated all the steps in the cultivation of truck crops and the commercial production of humus. At noon an excellent luncheon was served in the company's dining room. Everyone who visited the plant was much impressed by the extent to which the Alphano Humus Co. had gone in successfully commercializing peat.

PRODUCTION OF PEAT IN 1920.

By K. W. Cottrell,
United States Geological Survey.

As there was no great change or development in the peat industry in 1920 and the comprehensive reports published in Mineral Resources for 1914 and 1918 are still available for distribution, this report contains only the statistics.

Production.

As shown in the following tables, the quantity of peat produced for fertilizer and fertilizer ingredient increased more than 8,000 tons and for stock food more than 2,000 tons, but the quantity reported as dug for fuel fell off more than 7,000 tons, so the net gain in production was only 4,007 tons. On account of higher prices the total value of the peat sold increased more than $200,000 and was greater than in any preceding year except 1918.

Peat produced in the United States, 1916-1920.

Year.	Number of plants reporting.	Quantity (short tons).	Value.	Average price per ton.
1916	13	52,506	$369.104	$7.03
1917	18	97,363	709,900	7.29
1918	25	107,261	1,047,243	9.76
1919	15	69,197	705,532	10.20
1920	18	73,204	921,732	12.59

Peat used in manufacturing fertilizer in the United States, 1916-1920.

Year.	Quantity (short tons).	Value.	Average price per ton.
1916	48,106	$336,004	$6.98
1917	92,263	658,500	7.14
1918	79,573	775,313	9.74
1919	54,690	557,240	10.19
1920	63,272	773,635	12.23

PEAT USED IN MANUFACTURING STOCK FOOD IN THE UNITED STATES, 1916-1920.

Year.	Quantity (short tons).	Value.	Average price per ton.
1916	4,300	$32,250	$7.50
1917	5,100	51,400	10.08
1918	7,096	106,935	15.07
1919	6,402	98,940	15.45
1920	[1] 9,182	[1] 143,047	15.58

[1]Includes small quantity of moss and stable litter.

IMPORTS AND EXPORTS.

The imports of peat in 1920 consisted of peat moss or litter which is used largely for packing material. The quantity was 2,765 tons, or six times as much as in 1919. The price per ton, however, fell from $35 to $13. No exports of crude peat or peat products were reported in 1920.

SUMMARY.

PEAT AND PEAT MOSS USED IN THE MANUFACTURE OF PEAT PRODUCTS IN THE UNITED STATES IN 1919 AND 1920.

Kind of Product.	Production.		Imports.		Consumption.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
1919						
Fertilizer and fertilizer ingredient	54,690	$557,240	.....	.....	54,690	$557,240
Stock food	6,402	98,940	.....	.....	6,402	98,940
Fuel and miscellaneous products	8,105	49,352	.....	.....	8,105	49,352
Moss	.....	.....	464	$16,345	464	16,345
	69,197	705,532	464	16,345	69,661	721,877
1920						
Fertilizer and fertilizer ingredient	63,272	773,635	.....	.....	63,272	773,635
Stock food	[1] 9,182	[1]143,047	.....	.....	9,182	143,047
Fuel	750	5,050	.....	.....	750	5,050
Moss	([2])	([2])	2,762	36,201	2,762	36,201
	73,204	921,732	2,762	36,201	75,966	957,933

[1]Includes small quantity of moss and stable litter.
[2]Included with stock food.

Consumption.

The consumption of peat and peat moss (production plus imports) was 69,661 tons, valued at $721,877, in 1919, and 75,966 tons, valued at $957,933, in 1920.

Distribution of Peat Plants.

The 18 plants reporting production in 1920 were distributed as follows: California 3, New Jersey 3, Illinois 2, and Florida, Georgia, Indiana, Massachusetts, Michigan, Minnesota, New Hampshire, New York, North Carolina, and Wisconsin 1 each. Illinois was the largest producer, but the State total can not be published without revealing confidential information, as there were only two producers. New Jersey was second in rank, with an output of 26,623 short tons, valued at $281,527, and California third, with 9,927 tons, valued at $77,614.

Producers of Peat in the United States.

The following individuals and companies reported to the Geological Survey that they produced crude peat or peat products in the United States in 1920:

Alphano Humus Co., Whitehall Building, New York, N. Y.

American Peat Products Co., Morrison, Ill.

Appleton Peat Products Co., Appleton Wis.

Bacterized Humus Co., Lakeville, Ind.

Chapman, I. S., & Co. (Inc.), 937 Third Street, San Bernardino, Calif.

Day, James H.; 35 South Street, Milford, N. H.

Hennepin Atomized Fuel Co., 520 Security Building, Minneapolis, Minn.

Hyper-Humus Co., Newton, N. J.

McElhone, Asa., Fishkill, N. Y.

Marcrum, J. G., Netcong, N. J.

Michigan Humus & Chemical Co., Chassell, Mich.

Pacific Humus Co., 205 Central Building, Pasadena, Calif.

Phos-Pho Germ Manufacturing Corporation, New Bern, N. C.

Riverside Orange Co. (Ltd.), Arlington Heights, Riverside, Calif.

Saugus River Peat Products Co., Lynn, Mass.

Southern Humus Co., Smyrna, Ga.

Wiedmer Chemical Co., Pierce Building, St. Louis, Mo.

PEAT IN MICHIGAN.[1]

By E. K. Soper and C. C. Osbon.

The peat deposits of Michigan consist largely of "muskegs" and grass-sedge marshes in basins of glacial origin and are similar in most respects to those of Minnesota and Wisconsin. Except in Ontonagon and Baraga counties and in the southern part of Houghton County, peat is well distributed throughout all of the northern peninsula, but the most extensive deposits are located in the eastern part of that peninsula. The largest swamps, some of which exceed 25 square miles in area, lie in a region about 90 miles long and 30 miles wide extending eastward from Munising toward Sault Ste. Marie. The peat in these swamps varies from 2 to 20 feet in depth. Although there are many peat deposits in the southern peninsula of Michigan, few exceed 400 acres in area. The largest occur in river valleys and consequently contain a high percentage of ash. However, large quantities of good peat are found in nearly all of the lakes in the northern part of the southern peninsula. It is estimated that Michigan is capable of yielding 1,000,000,000 short tons of air-dried peat and that 80 per cent of this quantity is located in the northern peninsula. Many peat deposits in Michigan have been described in detail by Chas. A. Davis[2] and much of the data presented herein are based upon his work.

The following is a description of the deposits examined for this report:

Dickinson County.

Locality 1. *Deposit in the N. E. ¼ of sec. 7 and the N. W. ¼ sec. 8, Norway Township.* This deposit is about 130 acres in area and five feet deep and is estimated to be capable of yielding approximately 130,000 short tons of air-dried peat. The living vegetation consists chiefly of sedges and grasses, though scattered coniferous trees occur at the south end. The peat is

[1]Extract from an unpublished report on the Occurrence and Uses of Peat in the United States, prepared by the United States Geological Survey. Published with the permission of the Director.

[2]Davis, C. A., Peat, essays on its origin, uses, and distribution in Michigan: Geol. Survey of Michigan, Report for 1906, pp. 93-395, 1906.

dark brown, well-decomposed, of relatively uniform texture, and is underlain by sand. A typical sample (analysis 383) was obtained by mixing peat taken from several test borings. As the ash content is 17.41 per cent and the nitrogen 1.89, the peat appears to be suitable for the production of only low-grade fuel and fertilizer.

Eaton County.

Locality 2. *Deposit about 2½ miles east of Eaton Rapids, near the track of the Michigan Central Railroad.* This deposit is about 400 acres in area and 7 feet deep and as estimated would yield 560,000 short tons of air-dried peat. The peat is brown and fibrous, consists chiefly of the remains of grasses and sedges, contains many roots and pieces of wood, and is underlain by sand. The dominant living vegetation is grasses and sedges. The deposit has been well drained and a portion of it is used for the growth of cabbage. Two typical samples (analyses 351 and 352) were obtained by mixing peat taken from several test holes. A comparison of these analyses shows the peat to be comparatively uniform in quality. As the nitrogen content is high and the percentage of ash relatively low, the peat might be profitably used either for fuel or for a fertilizer ingredient.

Houghton County.

Locality 3. *Large bog in the Sturgeon River Valley near Klingville.* This deposit, which is 16 miles long and from 2 to 2½ miles wide, is about 36 square miles in area and 5 feet deep, and is estimated to contain the equivalent of 23,000,000 short tons of air dried muck and peat. The deposit was sampled at points along a line extending from east to west through its center. Samples were also collected near the main drainage ditches located at right angles to the other series of test borings. The upper 3 feet of peat is mossy and fibrous, and contains many roots and pieces of wood; the lower layers are brown, well-decomposed, soft, and plastic. The living vegetation consists chiefly of sphagnum moss, although tamarack, spruce, and swamp laurel are of common occurrence. The deposit has been

partly drained and about 300 acres have been cleared. A representative sample (analysis 372) was obtained by mixing muck and peat taken at depth intervals of 2 feet in 8 test-holes. Analyses 373 and 375 of both the raw and macerated muck and peat show that they contain too much ash for fuel. The nitrogen content is a little less than 2 per cent and is relatively uniform throughout the deposit.

Locality 4. *Small bog in the N. E. ¼ of sec.* 22 *and N. W. ¼ sec.* 23, *Calumet Township.*. The living vegetation consists chiefly of tamarack and small poplar trees, although some tufts of sphagnum moss are found. The peat is brown, fibrous, and contains much woody material. Four test borings were made and a typical sample (analysis 378) was obtained by mixing peat taken from each. The general appearance of this bog is misleading. Its topographic position and flora justify an asumption that it contains a large quantity of peat, but test borings show only a shallow accumulation of fibrous plant remains. There are many peat bogs of this type in the vicinity of Calumet and Osceola.

Locality 5. *Small bog near the tracks of the Duluth, South Shore and Atlantic Railroad, west of the Hecla Mine.* The deposit is 15 acres in area and 12 feet in average thickness. The upper layer of the peat has shrunk, producing an open fissure and exposing a cross section of the deposit. The peat consists chiefly of grass remains, is brown, coarse and fibrous, and is underlain by sand. A sample (analysis 379) was obtained from the exposed section. The nitrogen content is unusually high (2.53 per cent) and the ash content low, and, though the peat might be used for fertilizer, fuel could not be economically made from it because the bog has been drained to the bottom and the peat is too dry and fibrous to be shaped into blocks.

Iron County.

Locality 6. *Small bog located about in the center of sec.* 22, *T.* 43 *N.*, *R.* 32 *W.* This deposit is about 6 acres in area and 4 feet deep. The living vegetation consists chiefly of sedges and

sphagnum. The peat, which is composed of the remains of plants like those growing on the bog, is brown, fibrous and woody. Analysis 380 shows the quality of the peat in this bog. There are similar bogs occupying small depressions known as kettle holes in this vicinity.

Locality 7. Deposit located in the N. W. ¼ of sec. 21 *and the S. W. ¼ of sec.* 16, *Crystal Falls Township.* This deposit is about 90 acres in area and 3 feet deep. The living vegetation consists chiefly of sedges and reeds, though some trees are found at the north end. The peat is dark brown, and well decomposed, but not plastic, and consists chiefly of the remains of sedges and reeds. Four test borings were made at intervals of 100 yards at points along the line extending from north to south through the center. An average sample (analysis 381) was obtained by mixing peat taken at frequent depth intervals from each of the test holes.

Locality 8. *Bog in the N. W. ¼ of sec.* 30, *in the western part of sec,* 29, *the S. E. ¼ of sec.* 19 *and the S. W. ¼ of sec.* 20, *Bates Township.* This deposit lies east of Ice Lake and is about 120 acres in area and 3 feet in average depth. It is composed chiefly of the remains of mosses, reeds and sedges, and is dark-brown and fibrous. The living vegeatation consists principally of sphagnum and heath shrubs. A typical sample (analysis 382) was obtained by mixing material taken from numerous test holes. The high content of inorganic mineral matter (41.55 per cent) shows that the deposit contains muck which is unfit for fuel.

Kalamazoo County.

Locality 9. *Deposit near the Grand Rapids & Indiana Railroad north of Vicksburg.* This deposit is about 400 acres in area and 5 feet in average depth, and is capable of yielding 400,000 short tons of air-dried peat and muck. The surface layer consists of black muck and the underlying peat ranges from brown to black in color, is rather fibrous, and is underlain by sand. It occupies a basin-shaped depression that would be difficult to drain. The

living vegetation consists chiefly of sedges and grasses. A representative sample (analysis 347) was obtained by mixing peat and muck taken from 4 test borings made at points along a line crossing the middle of the deposit. The heating value (moisture-free) is 8,203 B. t. u. per pound, the ash content 12.71 per cent, and the nitrogen 3.58. The peat therefore seems well adapted for fuel or fertilizer.

Locality 10. *Deposit on the Kleinstueck Estate, in the southern part of the city of Kalamazoo.* This deposit is about 30 acres in area and 6 feet in average thickness. The peat is brown and rather fibrous, and is underlain by sand. Several test-borings were made near the center of the deposit, and a representative sample (analysis 350) obtained by mixing peat taken from each of the test holes shows the peat to be of excellent quality for fuel or fertilizer. Analyses 348 and 349 show the quality of dried and pressed peat taken from this deposit. A comparison of these analyses show that the deposit contains peat of relatively uniform composition.

Lapeer County.

Locality 11. *Deposit located south of the Grand Trunk Railway tracks a short distance east of Imlay City.* This deposit is about 200 acres in area and 8 feet in average depth. The living vegetation consists chiefly of grasses and sedges, and of scattered tamarack trees near the south end. The peat is dark-brown in color, well-decomposed and plastic, contains some woody matter, and is underlain by sand. Three test holes were made at intervals of 100 yards across the south end. A representative specimen (analysis 357) was obtained by mixing peat taken at depth intervals of 2 feet from each of these borings. The calorific value (moisture-free) is 9,186 B. t. u., and the nitrogen content 2.24 per cent. The peat should therefore make good fuel and fertilizer.

Luce County.

Locality 12. *Bog near the Duluth, South Shore and Atlantic*

Railroad west of Newberry. This deposit is about 150 acres in area and 4 feet in average depth. The peat, which consists chiefly of the remains of sedges and moss, and contains several thin layers of woody material, is dark-brown and well-decomposed. The living vegetation consists of spruce, tamarack, sedges, sphagnum, and numerous varieties of small shrubs. A typical sample (analysis 369) was obtained by mixing peat taken at appropriate depth intervals from 4 test holes made across the center of the bog.

Locality 13. *Large swamp north of Newberry.* This deposit is several hundred acres in area but contains peat only 2 feet in average depth. The living vegetation consists of spruce, tamarack, and a dense growth of shrubs. The peat, which was produced chiefly by the decay of sedges and grasses, is dark-brown to black, well-decomposed, and underlain by sand. Analysis 370 shows that the peat is of rather poor quality.

Marquette County.

Locality 14. *Bog in the northern part of the city of Marquette near the shore of Lake Superior.* This deposit is about 300 acres in area and 2 feet in average thickness. The living vegetation consists chiefly of grass, moss, and scattered coniferous and poplar trees. The peat is black and varies in texture from fibrous to plastic. Analysis 371 shows that it is fair in quality but the deposit is probably too shallow to be of economic value.

Mecosta County.

Locality 15. *Large swamp north and east of the village of Mecosta.* This deposit is about 3,500 acres in area, from 4 to 16 feet in thickness, and is capable of yielding approximately 4,900,000 short tons of air-dried peat and muck. The peat and muck are dark-brown, fibrous, and woody, and are underlain by sand and marl. The living vegetation consists chiefly of poplar, spruce, and tamarack trees. As there is a dense undergrowth of small shrubs the swamp is difficult to penetrate. The surface is thickly covered with old logs, stumps, slashings, and chips,

and other debris of logging operations. A series of test-borings was made at intervals of 100 yards along an east-west line across the center of the swamp. Representative samples (analyses 365, 366, 367, and 368) were obtained from these test-borings by mixing material taken at appropriate depth intervals. A comparison of the analyses shows that the deposit contains too much ash for good fuel. The nitrogen content, which ranges from 1.42 per cent to 1.97 per cent, is also low. The high sulphur content (3.48 per cent in analysis 366) is noteworthy.

Muskegon County.

Locality 16. *Muck marsh along the Muskegon River in the northeastern part of Muskegon Township.* This deposit is 3,000 acres in area and 5 feet in average thickness. The depth, however, is variable, and small pockets were encountered in sampling the deposits in which the organic matter was much more than 5 feet deep. The living vegetation consists of a heavy growth of marsh grass and bulrushes. At the north end beech and willow trees are numerous. The muck is brown and fibrous and contains a large percentage of inorganic mineral due to the large quantities of sand deposited at flood periods of the Muskegon River. The recurrent floods, which have covered this area, are recorded in the deposit by alternate layers of sand and organic matter. Numerous test borings were made throughout both the north and south sides of the marsh and a representative sample (analysis 364) was obtained by mixing material taken from the various test holes. According to the analysis the sample contains 58.32 per cent of ash and 1.57 per cent of nitrogen, and is therefore to be classed as muck rather than peat. Louis P. Haight, of Muskegon, is reclaiming this marsh for agricultural use.

Oakland County.

Locality 17. *Deposit near the center of sec. 32 in the southern part of Pontiac.* This deposit is about 40 acres in area and 2½ feet in average depth. The living vegetation consists of sedges and reeds. The peat is dark-brown, well-decomposed and plastic,

consists principally of the remains of sedges, and is underlain by marl. Several borings were made throughout the area and a representative sample (analysis 356) was obtained by mixing the peat from the various test holes. The peat contains an unusually large proportion of nitrogen (3.22 per cent) but is not thick enough to be workable commercially.

St. Clair County.

Locality 18. *Large marsh on the Grand Trunk Railroad three miles west of Capac.* This deposit is about 3,000 acres in area and 7 feet in average depth. The peat is brown and fibrous and is underlain by sand. The living vegetation consists chiefly of grasses, sedges, reeds, and the blueberry. Representative specimens (analyses 358, 359, and 360) were obtained by mixing peat taken at numerous places along the drainage ditch which extends longitudinally across the marsh. The peat is low in ash, high in calorific value, but it is too fibrous for the manufacture of machine peat fuel.

Shiawasee County.

Locality 19. *Bog about 2 miles west of Bancroft.* This deposit is 300 acres in area and 5 feet in average thickness. The living vegetation consists chiefly of sedges, grasses, reeds, bulrushes and tamarack trees. The peat is dark-brown to black, well-decomposed and plastic, and is underlain by impure marl and sand. Numerous test-borings were made through the center and composite samples (analyses 361, 362, and 363) were obtained by mixing peat from each of the test holes. The peat appears to be of good quality for fuel or for a fertilizer.

Washtenaw County.

Locality 20. *Bog in the southern part of Chelsea.* This deposit is about 100 acres in area and 3 feet in average depth. The living vegetation consists chiefly of grasses, mosses, and the blueberry. The peat is brown, fibrous, and flaky, and is under-

lain by impure marl and sand. Test-borings were made at intervals of 50 yards across the center of the bog and typical samples (analyses 353, 354, and 355) were obtained by mixing peat taken from each hole. A comparison of the analyses shows that the peat is uniform in composition and appears to be of the proper quality for fuel or fertilizer, but it is probably too shallow for commercial use.

Analyses of Michigan peat and muck.[a]

(F. M. Stanton, U. S. Geological Survey, analyst.)

Locality.	Laboratory number.	Condition of sample.[b]	Proximate. Moisture.	Proximate. Volatile matter.	Proximate. Fixed Carbon.	Proximate. Ash.	Ultimate. Sulphur.	Ultimate. Hydrogen.	Ultimate. Carbon.	Ultimate. Nitrogen.	Ultimate. Oxygen.	Air-drying loss.	Calorific val. Calories.	Calorific val. B.t.u.
Allegan County.														
Shelbyville, 4 miles southeast of. (Gun marsh)	c6725	1	77.22	.....	.....	.....	.....	.....	.....	.....	.....	75.40	.....	.....
Shelbyville, 4 miles southeast of	d6724	1	49.55	21.46	9.10	19.89	.36	.....	.....	.....	.....	45.30	1,638	2,948
		2	.....	42.54	18.03	39.43	.71	.....	.....	.....	.....	.....	3,247	5.845
Kalamazoo County.														
Kalamazoo, near (Elk marsh)	c6721	1	87.76	.....	.....	.....	.....	.....	.....	.....	.....	86.80	.....	.....
Kalamazoo, near (Elk marsh)	d6720	1	66.91	19.04	9.29	4.76	.09	8.97	17.23	.81	68.14	64.30	1,680	3,024
		2	.....	57.54	28.07	14.39	.27	4.65	52.07	2.45	26.17	.....	5,077	9,139
Kalamazoo, near (Elk marsh, cut peat)	d6722	1	11.93	53.52	28.38	6.17	.20	.....	.....	.....	.....	4.70	4,905	8,829
		2	.....	60.77	32.22	7.01	.23	.....	.....	.....		.....	5.570	10,026
Kalamazoo, near (machine peat)	d6723	1	13.51	54.46	25.91	6.12	.26	.....	.....	.....		6.50	4,722	8,500
		2	.....	62.97	29.95	7.08	.30	.....	.....	.....		.....	5.460	9.828
Livingston County.														
Hamburg, 1 mile west of	c6719	1	83.63	.....	.....	.....	.....	.....	.....	.....		82.40	.....	.....
Hamburg, 1 mile west of	c6718	1	53.85	30.00	13.26	2.89	.08	.....	.....	.....		50.40	2,449	4,408
		2	.....	65.00	28.74	6.26	.17	.....	.....	.....		.....	5,306	9,551
Monroe County.														
Lambertville, 12 miles north of Toledo, Ohio	c6300	1	90.78	.....	.....	.....	.....	.....	.....	.....		89.90	.....	.....
Lambertville, 12 miles north of Toledo, Ohio	d6299	1	18.65	49.13	24.21	8.01	.44	.....	.....	.....		11.60	4,137	7,447
		2	.....	60.40	29.75	9.85	.54	.....				.....	5,086	9.155

a Davis, C. A., The uses of peat for fuel and other purposes: U. S. Bureau of Mines Bull. 16, p. 197, 1911.
b1 Native peat.
b2 Moisture-free.
c Bottle sample.
d Sack sample.

Analyses of moisture-free Michigan peat and muck.

(H. M. Cooper, U. S. Bureau of Mines, analyst.)

Locality No.	County.	Proximate.			Ultimate.			Calorific value.	
		Analysis No.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.	Nitrogen.	Calories.	B. t. u.
1	Dickinson	383	54.39	28.20	17.41	1.33	1.89	4,293	7,727
2	Eaton	351	36.66	49.18	14.16	.49	2.83	4,348	7,827
2	Eaton	352	43.82	43.56	12.62	.50	3.00	4,481	8,066
3	Houghton	372	39.68	19.64	40.68	.36	1.44	.....	.....
3	Houghton	373	39.28	18.69	42.03	.32	1.99	.....	.....
3	Houghton	375	45.18	25.24	29.58	.33	1.94	.....	.....
4	Houghton	378	55.83	31.85	12.32	.27	1.96	4,725	8,505
5	Houghton	379	55.34	30.54	14.12	.61	2.53	.....	.....
6	Iron	380	49.47	22.98	27.55	.38	2.64	4,083	7,349
7	Iron	381	51.91	27.13	20.96	.56	1.99	4,608	8,294
8	Iron	382	41.08	17.37	41.55	.61	3.20	.....	.....
9	Kalamazoo	347	35.92	51.37	12.71	.46	3.58	4,557	8,203
10	Kalamazoo	348	34.51	49.50	15.99	.60	3.14	4,345	7,821
10	Kalamazoo	349	35.91	51.24	12.85	.61	2.82	4,579	8,242
10	Kalamazoo	350	37.16	52.17	10.67	.72	3.16	4,773	8,592
11	Lapeer	357	46.48	37.59	15.93	1.75	2.24	4,553	9,186
12	Luce	369	52.62	28.16	19.22	.90	1.86	4,369	7,865
13	Luce	370	55.21	23.68	21.11	.60	1.76	3,943	7,098
14	Marquette	371	52.84	31.46	15.70	.35	1.97	4,434	7,982
15	Mecosta	365	64.97	3.90	31.13	2.39	1.42	.....	.....
15	Mecosta	366	42.26	10.94	46.80	3.48	1.97	.....	.....
15	Mecosta	367	54.71	18.34	26.95	.41	1.97	3,424	6,163
15	Mecosta	368	57.61	16.77	25.62	2.18	1.69	3,738	6,728
16	Muskegon	364	23.84	17.84	58.32	.24	1.57	.....	.....
17	Oakland	356	50.46	31.00	18.54	.75	3.22	4,151	7,472
18	St. Clair	358	55.77	42.23	2.00	.27	.90	5,018	9,033
18	St. Clair	359	55.73	42.66	1.61	.25	.93	4,954	8,917
18	St. Clair	360	54.77	41.96	3.27	.22	1.43	5,039	9,071
19	Shiawassee	361	52.50	37.53	9.97	.39	3.51	4,767	8,580
19	Shiawassee	362	52.34	37.30	10.36	.43	3.39	4,749	8,548
19	Shiawassee	363	56.35	30.01	13.64	.57	3.25	4,627	8,328
20	Washtenaw	353	35.24	59.83	4.93	.20	2.30	5.266	9,479
20	Washtenaw	354	41.37	54.10	4.53	.20	1.96	5,401	9,721
20	Washtenaw	355	28.57	61.46	9.97	.23	2.55	5,201	9,362

PEAT AS A GAS MAKING FUEL.[1]

By F. P. Coffin,
General Electric Company.

Excavation and Drying.

In some parts of the United States and Canada that receive their coal supply by long transportation routes from distant coal fields, large deposits of peat are available. Peat, as it lies in the bog, contains 85 or 90 percent of moisture, and the heat required for its evaporation is practically equivalent to its normal value after drying. Taking the average moisture content as 87.5 percent, 7 tons of water must be eliminated to obtain 1 ton of theoretically dry peat. It may, however, be slowly dried in the air to a moisture content of from 20 to 60 percent, and may then be gasified in producers of either the Lymn or the horizontal rotary types. The evaporation of the residual moisture can be readily effected in the by-product gas producer where it lowers the temperature of the fire and thereby aids in the recovery of ammonia.

These last one or two tons of moisture are evaporated much more slowly, during air drying, than the first 5 or 6 tons with which a ton of theoretically dry peat is originally saturated. This fact, together with the necessity of handling such a large amount of material, have hindered the use of peat in competition with coal.

In Europe, where labor is cheap, peat has often been dug and handled manually. Various combinations of machinery have also been used. One of the suggestions that has been made for excavating peat is the use of suction dredges, but these are applicable only to large bogs which can be kept flooded.

The writer has tried some simple experiments in pouring a small stream of water on freshly dug peat and found that it may be readily disintegrated and converted into a wet sludge. This suggests the possibility of excavating peat from any kind

[1]Excerpt from the author's contribution on Coal Preparation and the Utilization of Coal on a Multiple-Product Basis to Bacon and Hamor's American Fuels, with the permission of Messrs. R. F. Bacon and W. A. Hamor, of the Mellon Institute of Industrial Research, Pittsburgh, Pa. The composite treatise, American Fuels, will be published by the McGraw-Hill Book Co., Inc., 239 West 39th St., New York, N. Y.

of bog, by means of hydraulic sluicing, during periods when a sufficient water supply is available. This procedure would be similar to the hydraulic mining of gold bearing gravels in the western states, excpt that smaller jets of water should suffice. Sluicing will wash out miscellaneous materials contained in peat, such as mineral matter and solid vegetable matter, and will leave them behind. This will simplify the clearing of the surface of the bog and will recover one salable by-product (peat litter) at the start. This consists of the softer living vegetable matter, such as mosses and root fibers, which are useful as bedding material for live stock.

The sludge can be pumped through pipes to the gas plant which may be located in a place which is suitable for a power station. The location may allow the receiving of coal by rail, as an auxiliary fuel for use during the months when drying is not possible. Peat, however, should be stored for winter use if practicable. The location should also have a large area of level land for drying. A possible method would be as follows:

Long parallel gravel dykes can be built and crane rails can be laid on their tops. The cranes would span the wide intervening ditches which would be used as settling basins. They would be filled with sludge and the clear water drained off through overflow pipes. The cranes would carry machines for excavating ditches in the surface of the peat for drainage purposes. Longitudinal ditches can be dug a few feet apart, with occasional cross ditches to carry off water. The wet peat from the ditches may be piled on the ridges in such a way as to give the surface a gentle slope for shedding rain water. The crane may also carry harrows for breaking up the suface to allow the top layer to dry by evaporation. Finally, the crane will carry apparatus for removing the top layer and conveying it to storage piles. These may be covered with tarpaulins to protect them from rain.

Where there are several bogs in the vicinity of the plant they may all be utilized in succession by this method. Most of the machinery will be centralized at the plant and the only machinery which need be moved around the bog will be some electrically driven pumps. Where peat bogs are located near navigable lakes or rivers the peat may be dredged and loaded

in scows. These will be towed to the plant and the peat may be removed by disintegrating it with water jets and pumping the sludge into the settling ditches.[1]

Some localities where peat may be used with good advantage to reduce the importation of coal from a distance are Quebec, Ontario, Manitoba, Minnesota, the New England States, and Florida. In the latter State there is the important advantage of being able to dry peat during practically all seasons of the year.

In most parts of North America, however, the expense of air-drying will offer a rather serious limitation to the substitution of raw peat for coal. It would, therefore, appear preferable to prepare peat for gasification by the wet carbonizing process.

The Wet Carbonization of Peat.[2]

Peat bogs are distributed all over the surface of the earth, and represent enormous deposits of carbon. Based upon Geological Survey reports giving the area and depth of bog land, it has been estimated that there is more carbon in the peat deposits than in all known coal fields.

The difficulties incident to air drying have been mentioned. The mechanical pressing out of water from peat has frequently been suggested, and experiments on a small scale with surface peat have given positive results; but the black fuel peat which predominates in peat deposits, does not give off its water when submitted to pressure.

Ekenberg claimed that one of the principal factors which rendered it difficult to remove the water by mechanical means was the presence in mature peats of a slimy hydrocellulose. He found that this could be destroyed by subjecting the peat to a sufficiently high temperature.

[1]The above method of drying is based on a method which was developed in Canada for the drying and pneumatic collection of peat from the surface of a bog. Consult Bulletin 16, U. S. Bureau of Mines, 1911, the Uses of Peat, by C. A. Davis, page 113. This method, however, involved the expense of laying tracks over the surface, as well as the clearing of wooded bogs. The writer has modified the plan to centralize the operation in connection with excavation by hydraulic sluicing. The latter operation should also be useful in connection with wet carbonization.

[2]Taken largely from paper by M. Ekenberg, of London, England, entitled "Fuel from Peat," and published largely in the Iron and Steel Institute, May 14, 1909.

Since the required temperatuures range from 155° to possibly 200° C, the heating is done in closed vessels and under pressure. The specific heat of the pulp is about 0.92 so that regeneration of the heat is necessary for economical operation. The pulp may be forced through a tubular regenerator with an ordinary sludge pump. Ekenberg found that from 57 to 65 percent of the heat could be regenerated, and the higher the temperature of carbonization, the greater is the efficiency of regeneration. The carbonization is instantaneous so that the time required is only that necessary for heating the pulp.

Installation Near Dumfries, Scotland.[1]

In a recent installation near Dumfries, Scotland, peat, containing as high as 93 percent moisture, was first made into pulp and then forced under high pressure through 2-inch steel tubes heated by steam jackets. After the peat had been wet-carbonized it was forced, under a pressure of 120 pounds per square inch, into filter presses, where the water content was reduced to about 25 percent. The peat cakes were then pulverized and the dust blown through boiler flues and dried to 2 percent moisture content. It was then pressed into briquettes weighing from 0.5 to 1.5 pounds with a calorific value of 11,200 to 12,500 B. t. u. per pound.

Products.

It is evident, from this, that wet carbonization can be used for the preparation of peat for either gasification, pulverizing, or briquetting. The first crude product, in the form of filter cakes, contains only a little more moisture than raw peat which has been thoroughly air dried to a moisture content of 15 or 20 percent, and considerably less than peat which has been dried in wet summers in Europe when the moisture content often cannot be reduced below 33 or 40 percent. This process is independent of the season and it reduces the various types of peat, both young and mature, to a product of more nearly uniform properties and fuel value.

[1]Chemical Eng. and Mining Rev., 1919, Vol. 12, pp. 76-9.
Journal of American Peat Society, Jan., 1921, p. 31.

The Ekenberg Process.[1]

In the absence of further information in regard to the Dumfries plant I shall briefly review the original process, as developed by Ekenberg in Sweden between 1904 and 1909.

The peat was dug and then thoroughly macerated by mechanical means at the bog. The macerating machine delivered the pulp to dumping cars which carried it to a storage tank. The wet-carbonizing apparatus consisted of 52 iron pipes 36 feet in length. Within each pipe was a rotatable inner tube which carried a worm upon its outer surface. The raw peat was forced into the annular space at the cold end of the tubes by a sludge pump under a pressure of 150 pounds per square inch, and was kept moving toward the hot end by the rotation of the worms without the loss of its initial static pressure. The tubes were heated in a furnace into which they projected for about one-half their length. The outer tubes were closed at the hot end and the carbonized peat returned through the inner tubes giving up its sensible heat to the incoming pulp.

The maximum temperature to which the material was subjected was about 155°C, and the pressure used was sufficient to prevent the volatilization of either the moisture or the hydrocarbons. The peat becomes blackened and fine-grained, losing its structural peculiarities. By the use of higher temperatures and pressures more complete carbonization is effected.

Gasification.

The press cakes should make an excellent fuel for the by-product gas producer, while the carbonized pulp could even more readily be prepared for gasification by the Trent water-gas process. It is already finely divided and only enough water need be pressed out to leave it with the proper amount for making water gas. If pulverizing be required it would be only a minor operation. Moreover, it may be possible to effect gasification at a lower temperature than is required in the case of coals of more mature rank. This should be favorable to the recovery of ammonia. Peat is under a disadvantage in competing with coal when it must be prepared in solid form. In this

[1]Condensed from Bulletin 16, U. S. Bureau of Mines, pp. 123 to 125. Op. cit.

instance, however, the advantage should be in favor of peat in localities where peat is available.

Briquetting and Distilling.

The press cakes should make an excellent material for distillation at low temperature, especially if carbonized fuel is wanted in localities where it is available. The following data indicate the results attained by briquetting and distillation at high temperatures.[1]

Ekenberg describes two types of products which were made by the dry carbonizing of the briquettes. Rapid heating produced a light porous product, similar in appearance to wood charcoal, which he called "peat charcoal." Slow heating produced a hard dense "peat coke" with smaller pores than ordinary coke. Slow heating allowed time for the bases to escape and resulted in a coke having a density of from 30 to 32 pounds per cubic foot (47 to 51 kg. per hectoliter), while coke from ordinary coal showed weights of from 36 to 45 kg. per hectoliter. The coke has a high crushing strength—from 3270 to 5645 pounds per square inch (230 to 357 kgs. per sq. cm.)

The calorific value of the charcoal and coke were as follows:

	B.t.u. per pound		Calories per kilogram	
Charcoal	13,700	14,000	7,600	7,800
Coke	13,140	13,880	7,300	7,700

Wet carbonized press cakes distilled in a retort at high temperature gave 17,472 cubic feet of crude gas per ton with an illuminating power of 15 sperm candles. The yield of coke was 33 percent. After the gas was purified with potash the yield was 14,851 cubic feet of 20 candle power. The gas was practically free from sulphur.

Economic Limitations.

B. F. Haanel[2] states that efforts are still being made to adapt the wet-carbonizing process to the manufacture of fuel on a

[1]Condensed from Bulletin 16, U. S. Bureau of Mines, pp. 123 to 125. Op. cit.
[2]B. F. Haanel, The Manufacture and Utilization of Peat Fuel, Am. Inst. of Chem. Engrs. Read June 29, 1920, at Montreal, Canada, and published in the April, 1921, Jour. of the Am. Peat Soc.

commercial scale. The development, however, has been delayed by economic limitations in connection with the removal of moisture, owing to the fact that it has been found difficult to remove a sufficient proportion of the water by pressing. Hence, a considerable amount of moisture was left to be removed by heat.

The hydrocellulose is a colloidal substance which occurs in all humified peats to a certain extent and, like all gelatines, possesses an enormous capacity for absorbing water. The destruction of its colloidal properties, however, does not perceptibly affect the capacity of the peat for absorbing water. The fact is that the better and older humified peats are themselves of a colloidal structure, or at least possess colloidal properties which limit the amount of water which may be removed by pressing, even after the destruction of the hydrocellulose. While, as a result of carbonizing, the altered peat does submit more readily to pressing, the increased quantity of water which can thus be separated is, in his opinion, not sufficient to enable this process to be conducted commercially.

In a water gas process, however, where external heating is employed[1], the proportion of moisture required may, in the writer's opinion, be as high as from 60 to 75 percent and it should be possible to reduce it to this figure by carbonizing and pressing.

In the by-product gas producer peat should be used which does not exced 35 per cent moisture content.

The process referred to is the Trent water gas process which will be described in the same chapter of American Fuels as th one in which this account will appear.

EASY MONEY FROM PEAT?[1]

Wonderful Invention for Extracting Methyl Alcohol and Gasoline Out of Peat and Money Out of the Pockets of Investors—Description of the Apparatus and of the Supertechnical Process Used, Which the Inventor Says Will Put Standard Oil Out of Business.

We count among our pleasant acquaintances a gentleman who retains the Yankee tradition of wanting to know; holding in maturity that engaging quality of curiosity which most of us enjoy as children, but which, to our great hurt, we are likely to slough off in some inexplicable manner before our student days are over. Our only regret in regard to what follows is that owing to a quality of intense shyness he withholds permission to mention names and places. We may say this much but no more, so we hasten to acquaint our readers with a record of his experience in "looking up an investment." Our comments may be a trifle fanciful, but there is no imagination in his statement of what he saw and what he heard. They were carefully recorded while his memory was fresh.

Wonderful Opportunity for Investment.

He learned of a wonderful opportunity for investment; an opportunity to make the original purchasers of telephone stock turn in their graves with envy; a chance to participate in a corporation for the development of a chemical processes that will (or perhaps in the interest of sound conservatism we had better modify the tense and say that *should*) make the Standard Oil Co. look like thirty cents. The great invention, he was told, consists in making 20 to 25 gallons of pure methyl alcohol and 120 to 125 gallons of high-grade gasoline out of a ton of

[1]The editor does not know who wrote this discussion, but he nevertheless congratulates the anonymous author. Legitimate peat operators are being constantly handicapped by just such false promotion. Peat is a commercial success as a conditioner and nitrogenous ingredient of fertilizer, as a component of stock food, and as a low-grade fuel. It has potential value as food for bacteria, but research work has not yet progressed far enough along this channel to clearly demonstrate the extent of that value. Peat is one of the most fertile soil types in this country. Most of the other uses of peat are largely problematical and have not been commercially demonstrated in this country. There is nothing mythical about the legitimate uses of peat and the successful processes are comparatively simple. The vacuum and so-called complete artificial drying processes for fuel, the economic removal of moisture by pressure and chemicals, and some of the nitrifying methods that have been reported, although not necessarily fraudulent, are considered by the best authorities as commercially impracticable.

peat—out of a ton of any old kind of peat. He availed himself of the opportunity to meet the inventor and his assistants, Charlie and George, together with upward of a dozen other gentlemen who were, partly already—partly pledged and partly prospective—investors. Most of them were actually men of means. He witnessed an official test of the process, and he saw the apparatus in operation.

On arriving at the place indicated, which is the site of the initial plant, he found the inventor installed in his office in a house, with a desk covered with papers, with bottles containing different colored liquids, and with numbers and cryptic labels that are not designed to be understood by the common, everyday chemist. The inventor was a very affable gentleman, well along in years, but showing no trace whatever of the infirmities of age. Our friend learned that the official test was to take place at 10:30 a. m., which was shortly after his arrival, and that the option to buy the stock held by the major portion of those present was to expire at noon.

Capitalists Cry For It.

"I might as well tell you, gentlemen," said the inventor, "that last night a group of New York capitalists came out with their chemist, and after an unofficial test which was carefully passed upon they were so taken with this process that they offered me $4,000,000 for 40 per cent of the stock! I couldn't accept because I am resolved to retain 60 per cent myself, and I felt in honor bound to have a talk with you beforehand."

At this point one of the investors interrupted him with "You shouldn't sell a share, Professor! We are able to provide all the funds you need."

Standard Oil Need Not Apply.

"Well," the Professor, as they called him, went on, "early this morning there was a group of California oil men out here; they drove out in automobiles; and they offered to pay me $500,000 cash for the rights in California, and somewhat less for similar rights in each of the two other Coast states, Oregon and

Washington. It looked tempting, because we could pay 40 to 50 per cent dividends on our stock from this offer without making a gallon of gasoline. One thing that held me back was that I can't make out whether they were Standard Oil men or not. I don't propose to let John D. Rockefeller or any of his associates buy one share of this stock. Why, two weeks after we begin to produce we shall have the whole Standard Oil crowd on their knees before us! I told those fellows I'd think it over till 6 o'clock this evening. I figure, though, that the rights are worth a good deal more than they offer. We can put up plants in nearly every major town in every State. They'd be getting their rights very cheap at those figures.

"Another thing I have to say is that our plant is progressing better and faster than I expected. The men have been very faithful. I am 50 per cent ahead on costs and 50 per cent ahead on construction. We can begin to turn out gasoline on Jan. 15.

Eight-Cent Price Is Profiteering.

"Now we can start out selling the gasoline for 20 cents a gallon. Of course we could sell for a good deal less. My agreement with you gentlemen who have subscribed is not to sell it below 10 cents a gallon, although we could sell it for 8 cents and still be profiteering. But there's no use in selling too much below the Standard folks. That would only mean a fight, and I don't see the use of it. Their gasoline has been costing them 14 8 cents a gallon. That is inside information, and I *know*. We shall be able to sell all we make all right."

"Professor," said Charlie, one of the assistants, "Did you tell the gentlemen about our success yesterday?"

"Why, no," said the professor. "I forgot all about it. There's an automobile dealer near by who wants to contract for half the entire output of our plant, and to pay for it in advance at 20c a gallon. There are a number of others also who are after it. We shall have no trouble in making sales.

"I'm almost getting ready to begin building a second plant. It's just a little matter of a real estate deal that's holding me back."

"But, Professor," said one of the investors, "wouldn't it be

better to start the one, and then build up extensions from the profits on the first?"

"No, sir" he replied. "I'm getting old and I want to put this thing through. I've no time to dally. We must have four plants in operation by July 1."

George (the other assistant) asked if he hadn't better go and get "that pressure tubing." It seems the evening before they had burst a piece, and George was urged to get into a motor and hurry back with the new one. Then Charlie said he thought all the gentlemen who were coming were there, and he suggested that they might as well start the official test. The Professor agreed to begin as soon as George returned; which he did shortly, with about 3 feet of rubber hose.

Components of the Mystic Apparatus.

He then led the way into a large cellar under his house, where, on an improvised table about 16 feet long and 2 feet wide, the mystic apparatus was set up. Unfortunately we lack working drawings, but the series consisted of:

1. A bicycle air pump.
2. The air cooler or purifier.
3. The combustion chamber.
4. The alcohol converter and catalysis chamber.
5. Condenser and alcohol receiver.
6. The pressure regulator.
7. The gasoline converter, catalysis chamber, and liquefier.
8. Gasoline trap.
9. Gasoline receiver.
10. An automobile tire pump containing a remarkable valve invented by the Professor, connected with the alcohol converter and the gasoline converter.

The Professor told the boys to fill up the condenser with water and then George took his place at the bicycle pump while Charlie manned the automobile tire pump that contained the remarkable valve.

He then explained how George pumped ordinary air into the system, and that the cooler, or purifier (which consisted of a coil of pipe, air cooled) cooled and purified the air before it

entered the combustion chamber. This (the combustion chamber) was a cylindrical apparatus provided with a grate underneath, and with an unused feeder above. The Professor took a few handfuls of moss, which was the peat, opened a door of the combustion chamber, put in his peat and then sealed the door shut. He lighted a bunsen burner, put it under the grate below the peat in the combustion chamber, and said:

"Now begin, boys." Tense excitement reigned while the Professor began gesticulating, like the walking beam of a steamboat; one hand up and the other dawn, then 'tother hand up and the first one down, first very slowly, and then speeding up slightly until they had good, synchronized action.

Not One Bit of Heat Wasted.

One of the guests placed his hand in the combustion chamber and remarked that it was cold, although the operation was already in process. The Professor cautioned all present to keep their hands off the apparatus, as it was very delicate, and then he explained to the inquirer that this was a peculiar feature of his invention. "The combustion," said he, "is going on all the time, but not one bit of heat is wasted. We use it all."

"Now that peat," he continued, "is all being burned to CO_2, except the ash," which seemed to our friend to be doing pretty well for the cold combustion of peat. "The CO_2," he explained, "is carried over into the alcohol converter, where the high vacuum is maintained, and there in the presence of a catalyst" (which he had discovered) "part of the CO_2 is converted into methyl alcohol."

In other words, we have at this point, which the Professor did not take the time to explain, the highly original reaction:

$$CO_2 + O_2 + N_2 = CH_3OH.$$

We don't want to steal any of the Professor's secrets, but we merely suggest that, in addition to his catalyst in the converter he may have an argon burner in the combustion chamber! The Professor didn't say so, but why shouldn't he have one? After this methyl alcohol reaction we are ready to believe almost anything. It might worry Irving Langmuir, but if he could

invent an argon-filled lamp why shouldn't the Professor invent an argon burner? However, things proceeded to happen so fast that we have no time to pause for a reply.

From the converter the unconverted CO_2 passes into a pressure regulator, of which only the outside was visible, and, according to the inventor, thence into the gasoline converter, which is the second catalysis chamber with a complex arrangement of baffles (which were not exhibited), and containing another catalyst which was discovered only after experimentation with "400 metals." This converter is operated under 300 pounds pressure, the Professor announced, and, to prove it, there was a pressure gauge that registered 300 pounds.

This variety of pressure, the "high vacuum" followed by 300 pounds to the square inch in the series of apparatus, was accomplished by means of Charlie working at the automobile tire pump which contains the Professor's remarkable valve. By this Charlie produced the high vacuum in the alcohol converter by the up-stroke, and the 300 pound pressure in the gasoline converter by the down-stroke.

That valve alone was worth going a long distance to see. Unfortunately it was so inclosed that our friend could not see it.

From the converter, which is also a liquefier, the gasoline passes out into a trap and thence into a gasoline receiver. That is the operation. In no more time than it has taken to tell it the Professor exclaimed, "The operation takes eight minutes, gentlemen, and" (looking at his watch) "seven minutes are gone—seven minutes and a half. Slow down boys!" And the walking beam motion began again with the Professor's elbows, while he looked diligently at his watch. "Slower. Seven an' three quarters. E-i-g-h-t minutes. Stop! Gentlemen, the operation is completed."

He opened the smaller alcohol receiver, and there it was, over half full of pure water-white methyl alcohol, 'absolutely pure excepting only for a little water in it," he said. The gasoline receiver was better still and showed a larger quantity. It also seemed to have more speed than the alcohol receiver because it leaked gasoline even before the pumps were started. "That," said the Professor, "is pure hexane, C_6H_{14}, 71 degrees pure. The gasoline you buy is only 57, but this is 71 degrees."

Gasoline "71 Degrees Pure."

Someone wanted to know what he meant by degrees pure. The Professor asked him if he was a chemist, and on getting a negative answer, he said, "It is rather hard to explain if you don't understand chemistry, but there are degrees of purity, and this is 71 against ordinary gasoline, which is only 57." Some people are never satisfied. It made the Professor a little testy, for he said:

"My gasoline is 71 degrees pure, and if you can get any in New York that is as pure as I am making here I'll give you my 60 per cent of stock in the company. At Eimer & Amend's you can get small bottles of very pure gasoline, but it isn't as pure as this."

We merely want to call attention to more wonders of catalysis in this invention, and to ask Prof. Bancroft, for instance, who has spent years in research on the subject what he has to say, or to call on Sir Ernest Rutherford to explain how he feels after his few atoms of hydrogen derived from an atmosphere of nitrogen, when either of them ponders over the Professor's final reaction which, as nearly as we can give it is

$$6CO_2 + xN_2 + yO_2 = CH_{14}.$$

Product Too Strong for a Ford Car.

The question was raised whether Henry Ford knew about this process, and it appears that he is not only thoroughly informed but that he is having a special truck designed for economical hauling with it. Then somebody wanted to know whether the gasoline had been thoroughly tested out with automobiles. "I should say it had," responded the Professor. "Charlie," he commanded, "come over here and tell this gentleman about that test we made the other day." "Well, sir," said Charlie, "we mixed some of it up with ordinary Standard Oil gasoline, fifty-fifty, and they drove a big car seventy-five miles on three gallons of it!" Then Charlie added a statement which may well induce automobile engineers to pause and consider. He said:

"Our gasoline is *too strong* for the ordinary Ford car."

Everyone present was deeply impressed. One of the investors said: "Professor, this is wonderful. It certainly beats the world. But you've got plenty of peat here. Would you mind making another run for us?"

"No," said the old gentleman. "I'm tired. Once is enough. What's the matter anyway? Any of you getting skeptical?"

"Oh, no, no. Not in the least. I only thought——."

Skeptics Told Where to Go.

Like many men of genius, the Professor is rather quick on the trigger, for he interrupted the speaker with:

"Look here; if you're getting skeptical you can go plum' straight to hell! I'll not be insulted with doubts. I don't need your money." Then, going over to Charlie, he caught him by the arm and said: 'Charlie, if any of these people are getting skeptical they can go straight to hell!" And with that he led the way upstairs to his office.

It lacked only twelve minutes of noon, and at noon the options expired. Try as we will we cannot pry out any information as to what happened before the sun reached meridian. How much was subscribed, or who subscribed, or who let his option lapse, is hidden from us. We have been told that before the "official test" which we have described about $200,000 had been underwritten and about $60,000 paid in. We have no knowledge of the commitments which followed the official test, or what became of the California oil men or the group of New York capitalists with their chemist.

One other pearl of information that we have from the Professor is that there is only 2 per cent of ash from peat as consumed by his process and that this is so high in potash and phosphorus that the fertilizer people are literally crying for it. And, aside from the ash, there is no waste, solid, liquid or gaseous, from the operation. "I convert everything," said the Professor. We should say he did.—*Chemical and Metallurgical Engineering*, February 2, 1921.

NEWS OF THE DOMESTIC INDUSTRY.

Minnesota.

Cut Peat Used for Fuel.

Several tons of peat have been cut for experimental purposes from the beds at Morton and are being dried. Some of the peat will be used in the state mineral lands office for fuel, according to F. A. Wildes, State Mine Examiner.

Frequent requests are received for samples and Mr. Wildes has arranged to make the peat available to anyone who desires it.

Residents of Morton are using the peat quite extensively.

Experiment Station Working on Peat Fuel Process.

Development of a process by which peat may be profitably produced in Minnesota is being undertaken by the State University, according to Edward Davis, superintendent of the mines experiment station.

New Peat Fuel Company Organized.

Articles of incorporation have recently been filed by the Northern Peat Co., of St. Paul. The company is associated with the Hennepin Atomized Fuel Co. and the St. Paul Atomized Fuel Co., which are erecting plants and equipment to produce pulverized fuel. The Northern Peat Co. is to conduct the operation in the peat bogs for the two concerns. It is capitalized for $100,000 and the incorporators are F. E. Bryan, John Pears and Woodlief Thomas.

Suggests State Produce Peat and Iron Ore.

The establishment of State-owned iron ore reduction plants using peat fuel and ore from state properties was recently suggested by F. A. Wildes, State Superintendent of Mines, in a report made public a short time ago.

New York.

Enright Sued for Fraud.

Louis Enright, of Farmingdale, who achieved newspaper notoriety a year ago when he claimed to have discovered a process whereby he could manufacture gasoline for 2 or 3 cents a gallon, is made defendent in a court action filed here by William H. Doolittle, of Woodmere, who seeks to recover $1,000 which he says he invested in the capital stock of the Enright Peat Gasoline Corporation, of which Louis Enright is president.

Doolittle alleges in his complaint that at Farmingdale last November Enright showed him a machine which he said he invented for the manufacture of gasoline from peat. Some peat was fed into the machine and Doolittle was then shown a bottle containing gasoline which he says Enright told him had just been manufactured from the peat. He charges in his complaint that Enright obtained the $1,000 from him fraudulently. Doolittle has brought suit also in a civil court to get his $1,000 back with interest.

NEWS OF THE INDUSTRY IN FOREIGN COUNTRIES.

England.

FIRES THAT NEVER GO OUT.

There are domestic fires burning in Yorkshire, England, today which have never been out for hundreds of years. At the old-fashioned farm houses in the dales of Yorkshire peat is still burned. The fuel is obtained from the moors and stacks of it are kept by the farmers in their stack garths.

The country round about is noted for its "griddle cakes," which are made from dough baked in quaint pans suspended over the peat fires. These fires are kept glowing from generation to generation, and the son warms himself at the fire which warmed his sire and his grandsire, and his grandsire's sires, and which will warm his son and his son's son.

There is a fire at Castleton, in the Whitby district, which has been burning for over two hundred years. The record probably is held by a farmhouse at Osmotherly, in the same district. This fire has been burning for five hundred years, and there are records to show that it has not been out during the last three centuries.—*Philadelphia Inquirer*, May 22, 1921.

Ireland.

THE RECOVERY AND FUEL VALUE OF IRISH PEAT.

The British Department of Scientific and Industrial Research has brought out a valuable report on the winning, preparation, and use of peat, particularly in Ireland,where the bogs are estimated to cover about 3,000,000 acres, more than one-half of which area is "red bog" as distinct from "mountain peat soil." More than 1,000,000 acres of these bogs represent the flat and deep bogs, three quarters of which are concentrated within the central belt, bounded on the north by a line joining Howth with Sligo, and on the south by a line joining Wicklow with Galway.

These bogs are estimated to average at least 17 feet in depth,

and this great tract of 1,000,000 acres of flat bogs contains upward of 2,000,000,000 tons of anhydrous peat. The board considers that the total content of all Irish bogs is between 3,000,000,000 and 3,500,000,000 tons of anhydrous peat, or say, 4,000,000,000 tons of air-dried peat. At the present rate of peat consumption, say, 6,000,000 tons per annum, and allowing that all the imported coal (4,650,000 tons) were replaced by peat fuel on a basis of 2 tons of air-dried peat to 1 ton of coal, that is, about 9,000,000 tons of peat, the peat deposits would satisfy the fuel and power requirements of the country for more than 250 years.

Recovery of Important By-Products.

What is more important from the American point of view is the economic value of peat as fuel. Between 1910 and 1913 the price of exported coal at Cardiff varied from 14s. to 15s. 10d. per ton. The trend of coal prices has been steadily upward, and they are now extremely high. "It does not seem likely," the board states, "that prices will undergo any material reduction for many years." But even assuming coal at 15s. per ton, and accepting the conservative calorific equivalent of 2 tons of peat to 1 ton of coal, the competing price of fuel is fixed at 7s. 6d. per ton at the same place, no account being taken of the value of the by-products. The board is of the opinion that so far as Ireland is concerned, peat fuel can be won in large quantities at a price per ton, including all charges, below this figure.

As to by-products, it is stated that when the peat or coal is first gasified, with by-product recovery, account must be taken of the value of the sulphate of ammonia obtained as a by-product, and it will then be seen that when the fuel is used in this way peat for fuel purposes is in a much stronger position to compete with coal than would appear from thermal considerations alone. Since 1 per cent of nitrogen=22.4 pounds of nitrogen per ton of anhydrous peat=16.3 pounds of nitrogen per ton of air-dried peat (25 per cent water) and also 1 pound of nitrogen yields theoretically 4.714 pounds of sulphate of ammonia, it follows that 1 ton of air-dried peat (25 per cent water) containing 1 per cent

nitrogen on anhydrous value would give theoretically 79.2 pounds of sulphate of ammonia. If the recovery of the maximum amount of ammonia per ton of peat is the aim rather than the production of the maximum amount of power, an efficiency of 70 per cent is stated to be regularly attained in practice.

Relative Costs of Coal and Peat.

At present coal is largely employed in Ireland, even among the farmers, but it is high priced. Peat, however, is plentiful and can be sold in Dublin at a lower rate than coal; that is to say, when coal was selling in Dublin at 10s. to 15s. per ton, peat was being sold at 7s. 6d. It is believed that this cost can be materially reduced if the peat is collected at the bog and stored in a central depot located nearer a large consuming center. To compete with coal, peat must be produced at a price less than half the market value of the latter, owing to its lower calorific value (it requires 1.77 tons to equal 1 ton of coal) and to the higher cost of transportation (a ton of peat occupying 3.93 times as much space as a ton of coal.)

From the conclusions arrived at by the Fuel Research Board it is estimated that from the one peat area to be exploited 100,000 tons of air-dried peat can be obtained each year, and can be sold at 5s. to 6s. per ton at a factory not more than 3 miles from the bog site. The board recommends the establishment of electric power stations at the bogs and the ultimate reclamation of the peat-denuded area.—*Commerce Reports*, May 25, 1921.

SOIL SURVEY.

Rock County, Wisconsin.

By W. J. Geib and Others.
United States Department of Agriculture

Peat.

Peat, as mapped in Rock County, consists of vegetable matter in various stages of decomposition, mingled with varying proportions of mineral matter. It typically consists of black or dark-brown fibrous to rather finely divided vegetable matter, mixed with a small amount of fine sand and silt. The depth ranges from 1½ to 20 feet, averaging about 4 feet. The greater part of the peat is quite fibrous, but in a number of places it is fairly well decomposed and tenacious, so that it can be molded with the hands. When dry this well-decomposed peat somewhat resembles a black, carbonaceous clay. In areas of sandy soils peat is frequently underlain by sandy material, while in regions of heavy upland soils the underlying material is clayey in character. Most of the areas of peat are underlain by material as heavy as loam, or heavier. The largest areas underlain by sand occur along Raccoon Creek in Newark Township. Probably 95 per cent of the remaining areas are underlain by heavy material.

Peat occurs most extensively in the marshes of Lima and Milton Townships, along Allen Creek south of Evansville, along Bass Creek between Footville and Afton, and on Raccoon Creek. Smaller areas are scattered west of the Rock River.

The surface is low, level, and very poorly drained. During early spring some of the marshes are entirely covered with water, but later in the summer many areas of peat are sufficiently dry and firm to bear the weight of farm animals, so that they can be pastured or cut for hay where there is a growth of wild grasses. In the areas covered by the Late Wisconsin moraine the peat beds largely occupy old lake basins, ponded valleys, kettle basins, glacial sloughs, and other depressions in the uneven surface developed by the glacial ice sheet, and small bodies are also developed in the flood plains of streams. In the

remainder of the county, all of which is covered more or less by pre-Wisconsin drift, the peat beds are confined wholly to stream flood plains.

Peat has been formed through the growth and partial decomposition in the presence of water of a rank vegetation, the black or dark-colored material being formed largely from grasses and sedges, and that having a brown color chiefly from sphagnum moss. About the margins of the larger marshes and over the greater part of the smaller ones varying quantities of mineral soil from the adjoining higher land have been washed in and incorporated with the vegetable matter. Although the greater part of the peat occurs within the region where the upland soils are made up in part of limestone material, some of it is in an acid condition. This is usually the case in the center of the larger marshes, while many of the smaller ones are not thus affected.

The native growth in the peat areas consists of several varieties of grasses and sedges, arrowhead, cat-tail, various reeds and rushes, and sphagnum moss.

Only a very small percentage of the peat of Rock County has been ditched and reclaimed. Where thoroughly drained and properly handled it produces good yields of corn, mixed timothy and alsike, oats, potatoes, onions, celery, and cabbage.

The peat is very rich in nitrogen, and the best practice is to use commercial fertilizers in preference to stable manure, which can be used to better advantage on the upland soils. The peat in this county runs very low in both phosphorus and potash. The former can be supplied by applying 1,000 pounds of finely pulverized rock phosphate per acre, followed by 400 to 600 pounds each 3 or 4 years thereafter. For sugar beets and cabbage from 250 to 300 pounds of either muriate or sulphate of potash should be applied per acre, for corn and potatoes about 150 pounds, and for cereals and hay grasses 100 pounds. Dry, unleached wood-ashes contain 3 to 5 per cent of potassium, so that an application of a half ton per acre would be equivalent to 100 pounds of high-grade sulphate or muriate

Peat, shallow phase.—The shallow phase of peat consists of 10 to 18 inches of black or dark-brown vegetable matter in varying stages of decomposition, mixed with more or less sand,

silt, or clay. This phase is developed in small areas in the southeastern and northeastern townships of the county, and along Waukoma, Allen, Marsh, Bass, Raccoon, Norwegian, and Taylor Creeks, and Sugar River.

In topography, drainage, and character of vegetation this phase is similar to the typical peat. The same methods of improvement and the present fertilizer requirements are also essentially the same.

Some of the marshes are underlain with clay, clay loam, or silt loam at a depth of only 12 to 15 inches. When these are first drained there is often a marked need of potash fertilizer or barnyard manure for a few years, but later this need partially or entirely disappears. This seems to be due to the settling of the mucky layer upon being drained and worked, permitting the underlying material, which contains a good supply of patassium, to become mixed with the organic material so as to supply plants with potash.

REPORT OF THE SECRETARY-TREASURER OF THE AMERICAN PEAT SOCIETY

For the fiscal year ending June 30, 1921.

RECEIPTS.

Subscriptions from members	$1,027.26
Journals sold	152.30
Advertisements	79.10
	$1,258.66
Cash on hand July 1, 1920	229.18
	$1,487.84

DISBURSEMENTS.

Printing and mailing Journals:	
July, 1920	$ 210.30
Envelopes	8.75
October, 1920	232.81
Index	31.33
January, 1921 (on account)	200.00
April, 1921	171.89
	$ 855.08
Editor's expenses	142.63
Annual meeting, 1920	112.84
Subscriptions to periodicals	7.20
Mimeographing	13.40
Clippings	24.00
Stationery	45.35
Bank collection charges	8.70
Transferring back numbers of Journal from New Brunswick to New York	71.69
Postage and Telegrams	8.13
Express	4.30
Cash on hand June 30, 1921	194.52
	$1,487.84

Statement.

BILLS RECEIVABLE.

Balance due for advertisements in Journal	$ 33.60
Unpaid subscriptions	222.50
Back numbers of Journals sold	50.90
Cash on hand July 1, 1921	194.52
	$ 501.52

BILLS PAYABLE.

Balance due for printing January Journal	$ 278.76
Surplus	222.76
	$ 501.52

Membership.

Total membership July 1, 1921		202
Enrolled during year	76	
Resigned during year	13	
Deceased during year	1	

Gain in membership since January 1, 1918.....158 per cent

Respectfully submitted,

CHAS. KNAP, *Secretary-Treasurer.*

ABSTRACTS OF PATENTS.

System of Handling Peat.

By Ernest V. Moore.

This invention relates to improvements in a system of handling peat, and the object of the invention is to provide a continuous system for economically cutting, spreading, piling or cubing, and stacking the peat in form convenient for loading into transport vehicles.

A further object is to provide a system which may be operated at a minimum of cost and with a minimum of labor.

A still further object is to provide a system which may be carried out with a minimum amount of simple and rugged machinery.

According to this invention, the working area is preferably laid out with a view to obtaining a maximum length, so that the apparatus may travel for long periods of time in one direction (a minimum of one day being preferred), without loss of time in reversing. The excavator and macerator are preferably located on a single platform which is mounted on caterpillars. This whole arrangement is provided with a reversible drive, so that it may travel up and down along a working face without any time being lost in turning the apparatus around. A bridgework extends from the platform at right angles to the direction of travel and is supported at its outer end on a caterpillar which is driven by a shaft extending through the bridge. This bridge supports an endless conveyer and draws at any point throughout its length a peat spreading apparatus. At the outer end of the conveyor is a dry peat stacking elevator.

The equipment consists of a platform mounted on caterpillars and provided with an excavating device of any suitable type and with a macerator into which the excavating device discharges peat. Under ordinary circumstances, the apparatus will be run by steam power, since fuel in the form of peat is always on hand. Where electric current at low cost is available, it may be used if desired, being conveyed to the various driving motors in any suitable manner. Where steam is used, the boiler and the

various engines necessary will be mounted on the platform. The caterpillars of the platforms preferably have independent drives and reversing gear, so that the platform may be maneuvered as desired.

A bridge is provided hinged at one end to the platform and supported near the opposite end on a caterpillar. This caterpillar is preferably driven from the same source of energy as the caterpillars under the platform, but means are provided in the drive so that the end caterpillar may be operated independently of the platform caterpillar. The bridge carries an endless belt conveyor, which is preferably driven from the macerator.

At the outer end of the bridge, an elevator is provided, preferably driven from the conveyor. A peat spreader of any suitable type or design is releasably attached to any suitable part of the bridge in such a manner that it may be shifted along the bridge to other locations. Any suitable form of unloading device is provided for the conveyor and is adjustably mounted on the bridge, so that it may be thrown into or out of operation or moved to a new location on the bridge when the spreader is moved. If desired, a hopper may be movably mounted on the bridge, so that it may be located at any suitable point to discharge on to the conveyor.

The operation of the system is as follows:

The apparatus moves along under its own power and the excavator removes a predetermined number of cubic feet of peat per minute which it discharges into the macerator. The macerator works the peat into uniform consistency, water being added if necessary, and discharges the peat to the conveyor which transports it to the spreading device attached to the bridge. The unloader is set in operative position to remove peat from the conveyor and discharge it into the spreader. As the apparatus moves along, the spreader deposits the peat on the ground in a form closely resembling bricks arranged end to end in rows. For the purpose of further description, the word "row" will be used as applied to the deposit of the spreader at each trip; thus a "row" will be many bricks in width and will extend the full travel of the apparatus. The apparatus continues moving over the ground, cutting and spreading continuously. When the end of the cut is reached, the spreader is shifted out

along the bridge, so as to spread another row and the whole apparatus moved laterally the amount of the cut. When the peat laid in the first row is dry or nearly dry, it becomes available as fuel to generate power necessary to operate the apparatus. Assuming that the time required for the preliminary drying of the peat is thirty days and that the apparatus requires three days to travel the length of its cut, it will be seen that ten cuts will be made and ten rows of peat laid out for drying. As the peat in the various rows approaches a state of proper dryness, operators are positioned on the bridge and arrange the bricks of peat in small piles at suitable intervals on the ground. These operators lie prone on the bridge or on a platform suspended there below, where they can easily reach and pile the peat bricks. These operators, being carried on the bridge, pile or cube the peat at exactly the same rate it is spread. Working at an absolutely uniform rate controlled by the machine and working under comfortable conditions, these operators produce a maximum of result with a minimum of effort, so that great efficiency is obtained in this part of the work. Following the foregoing hypothesis, when the ninth row is spread, the unconsumed peat in the first row is dry and the cubers or pilers throw it over into the second row, thus leaving the first row clear. The spreader is now brought back to a position approximately over the first row and the spreading operation continued. While the first row is being re-spread the hopper is positioned on the bridge above the second row and operators working on the second row throw the cubes or piles of dry peat into the hopper. The peat falls from the hopper onto the conveyor, which transports it to the outer end of the bridge and delivers it to the elevator. The elevator at this stage is extended in an almost horizontal position, so as to stack the peat the maximum distance from the end of the bridge. When the first row has been re-spread, the second row is clear and the spreader and hopper are moved over so that spreading of the second row and harvesting of the third row are carried on simultaneously. This operation continues until the peat in the first row is dry enough for piling, whereupon the piling or cubing is carried on simultaneously with the spreading and harvesting. The system is now in full operation and will continue in this manner as long

as weather conditions permit. When the entire drying area has been harvested once and is about to be respread, the whole apparatus will have been moved laterally on the drying area a distance equal to the surface width of all the cuts made. This movement at each cut enables the angle of the excavator to remain uniform. Each time the apparatus is thus moved laterally, the stacking elevator is slightly raised, so that its outer end will be over the center of the peat stack.

The exact movement of the apparatus can best be understood when described in connection with a particular example of time and distance. It is therefore considered that the time of drying is thirty days, the speed of the apparatus four feet per minute, or 5,760 feet in twenty-four hours, which is a little over a mile. Assuming that the nature of the area operated upon permits the machine to operate continuously in one direction for three days, it will be seen that only ten rows of peat need be laid to dry at one time. When the tenth row is laid, the first row will be completely dry and the row may be cleared preparatory to re-laying. Assuming the width of the spreader to be 12′, this gives a drying area 120′ wide and approximately 3 miles long. Assuming the depth of peat in the bog to be such that each cut represents a horizontal distance of 9″ on the surface, the machine will have cut toward the dry peat stack ten cuts of 9″ each or 7½′. Before starting each new cut the apparatus is maneuvered sidewise this distance of 9″ and thus encroaches to a certain extent on the adjacent edge of the drying area. Since, however, the entire bridge and the spreader, etc., move laterally with the excavator, the encroachment on one edge is made up by an equal extension of the drying area at the opposite edge. It is for this reason that the dry peat stack is made as far as possible from the edge of the bridge. The operation now continues as previously described until the whole area has been respread for drying. This continues throughout the season, which in Canada is approximately four months. It will thus be seen that the cycle of operations occurs only four times in the season. It will also be seen that in the course of the season, the excavation is a strip 30′ wide and a little over 3 miles long. When the enormous areas occupied by peat bogs are considered, it will be seen that it is a comparatively easy

matter to provide for a three-mile travel, even in a straight line. An ordinary section of land (640 acres) has a perimenter of 4 miles, so that making allowance for loss in turning the apparatus through a large radius curve at the corners and also allowing for a gangway several hundred feet wide in the center of the section, it will be seen that a cut of over 3 miles can be obtained by working around such an area. It will also be seen that as the annual cut is only 30′ in width, a considerable number of years must elapse before even so small an area as 640 acres is exhausted. Obviously, the greatest efficiency of operation is obtained when working on a large site of somewhat elongated form, on which the apparatus would require five or six days to lay one row. This would mean only five or six rows during the time of drying and would mean a shorter, cheaper and more easily handled bridge. Under these conditions, the maximum area will be worked, for the reason that the area unworkable according to this system is a strip slightly wider than the whole apparatus. Thus if the rows are extended in length, the bridge may be reduced in length and the unworkable area will be may be reduced in length and the unworkable area will be reduced accordingly. Moving at a speed of 4′ per minute and taking a 9″ cut off a cutting face 6′ to 8′ deep, the system will produce about 6 tons of fuel per hour, or in a working season of 100 days, approximately 14,400 tons. Since even as small an area as 640 acres may be worked for a number of years, it will be seen that the output from such an area is very large.

From the foregoing, it will be seen that the length of the cut expressed in days divided into the maximum time of drying determines the length of the bridge expressed in number of rows, for any given locality. If in a locality, the weather conditions are exceptionally favorable and the peat is found to dry in say 20 days in place of 30 days, the spreading will be stopped as soon as the first row is found to be dry enough for harvesting and respreading of the drying area will commence without waiting to spread the whole area. If the time of drying in a locality is unusually great or if it is impossible to secure the desired length of cut, compensation will have to be made by way of increasing the length of the bridge. It may therefore be necssary to provide more than one supporting caterpillar for this bridge. As

it obviously would not be practicable to have these intermediate caterpillars travel over the drying peat in the rows, it is necessary to provide unspread spaces for them to travel in. This is automatically done by the shifting of the whole apparatus between cuts. If the spreading device is moved over exactly its own width at the end of a row, it will be obvious that when the whole apparatus is moved to take the fresh cut, the spreader will be moved this distance away from the last row spread. This also provides automatically for trackage for the wheels of the spreader. If, in addition to the movement of the whole apparatus, the spreader is moved slightly more than its width each time, there will obviously be a still greater space left vacant between the rows.

The apparatus preferably works back and forth so that no time will be lost in turning it around. The apparatus runs to one end of its cut, is adjusted laterally for the fresh cut, the spreader and harvesting hopper moved on the bridge as required, and the drive reversed.

While the peat has heretofore been spoken of as stacked in a row at one side of the drying area, it will be understood that this is not essential. The adjustable stacking elevator permits the delivery of a season's harvest along a given line and it will therefore be entirely practicable to lay tracks along this line and have the elevator discharged directly into them. By arranging for an adequate number of cars, the entire harvest of peat may be removed as it is gathered, so that there will be no accumulation. On the other hand, the peat may be stacked in the manner first described and loaded as desired into cars running on a track located on the remote side of the stack from the harvesting apparatus. In this connection, it is to be noted that the method of gathering the peat from all over the drying area by means of the same conveyer which is used to spread it enables this operation to be carried out very economically, both as regards capital investment and operation cost. As compared with the ordinary method of gathering peat from the drying areas by means of wagons, it shows a very great economy.

The cut has hitherto been spoken of as if it was in a straight line or following the perimeter of a rectangular area. This is

not essential, as the apparatus being easily maneuvered may follow the contour of the land, that is to say, the apparatus may follow the line where the peat is of uniform depth, so that very little adjustment will be required.

Having thus described my invention, what I claim is:

1. A method of handling peat which comprises simultaneously excavating peat, spreading the peat for drying, cubing the dry peat, and gathering and stacking the dry peat by means of a single apparatus advancing continuously over a working area.

2. A method of handling peat which comprises continuously and simultaneously excavating peat, spreading the peat for drying, and gathering the dry peat by means of a single apparatus.

3. A method of handling peat which comprises driving a conveyer repeatedly over a drying area and using said conveyer from one end to an intermediate point for the conveyance of wet peat, and using the remainder of the length of said conveyer for the conveyance of dry peat.

4. In a method of handling peat the steps of simultaneously conveying wet peat and dry peat in the same direction on a single conveyor, the wet peat being carried from one end of the conveyor to a movable unloading point intermediate the ends of the conveyer, and the dry peat being carried from adjacent the unloading point to the second end of the conveyer.

5. A method of handling peat which comprises repeatedly and simultaneously spreading peat for drying, and gathering dry peat from a working area, and excavating peat on one edge of said area, and discharging dried peat adjacent the opposite edge of said area, simultaneously with the spreading and gathering, the excavating, spreading, gathering and discharging being carried out by means of a single apparatus advancing continuously and passing repeatedly over the area.

6. A method according to claim 5, in which the spreading and gathering steps are carried out on an area moved laterally on each repetition of the process a distance equal to the width of cut resulting from the step of excavating.

7. A method according to claim 5, in which the spreading and gathering steps are carried out on an area moved laterally

on each repetition of the process a distance equal to the width of cut resulting from theh step of excavating, and in which the dried peat is discharged along a fixed line until the area required for carrying out the steps of spreading and gathering the peat encroaches on the discharge line.

8. A method of handling peat, which comprises continuously excavating peat, spreading the peat to dry, and gathering the dry peat, the various stages of the process being carried out in rotation on parallel divisions of a drying area and simultaneously on the whole drying area.—U. S. Patent 1,373,627.

Peat Spatulating Machine.

By Franklin Farrow.

Inventor's Claims.

1. In a peat spatulating machine, the combination of a cylinder adapted to receive material at one end and to deliver treated material at the other end, and a rotor mounted in the cylinder, said rotor having a plurality of spiral rows of teeth upon its peripheral surface extending outwardly therefrom and terminating in spaced relation from the inner wall of the cylinder whereby to provide a spatulating chamber between the teeth and the cylinder, said teeth being arranged to extend in planes oblique to the longitudinal axis of the rotor and being inclined backwardly with respect to the direction of rotation of the rotor whereby to effect a wiping action of the teeth against the body of material and to impel the material forwardly between the rotor and the cylinder.

2. In a peat spatulating machine, the combination of a cylinder and a rotor in the cylinder, means for delivering material to one end of the cylinder, means for delivering material from the other end of the cylinder, and a plurality of teeth carried upon the peripheral surface of the rotor and extending in a general direction toward the inner wall of the cylinder to impinge material between the teeth of the cylinder, said teeth being inclined transversely at substantially 30° whereby said teeth are adapted to effect a wiping action against the material in the cylinder and to advance the material forwardly therein. —U. S. Patent 1,378,775.

Peat Fuel.

By Samuel C. Davidson.

Inventor's Claims.

1. The process of preparing fuel from peat, which consists in stirring wet peat as obtained from the bog into an approximately putty-like consistency, gradually adding powdered pitch and powdered dry peat thereto, during the continuance of the said treatment, continuing the stirring treatment until the three materials are blended together to form a homogeneous cass, and pressing the same into blocks.

2. The process of preparing fuel from peat, which consists in stirring wet peat as obtained directly from the bog into an approximately putty-like consistency, gradually adding thereto, during the continuance of said treatment, enough powdered pitch to give a luminous flame, and enough powdered dry peat to give coherence without excess of moisture, continuing the treatment until the materials are blended together to form a homogeneous mass, and pressing the mass into blocks.

In witness whereof I have hereunto signed my name in the presence of two subscribing witnesses.—U. S. Patent 1,384,012.

Brown Coal and Peat.

By K. Jacobs.

A semi-coke adapted to form a substitute for gas coal is obtained from brown coal or peat by heating the pre-dried material in a vessel with the outlet open until low temperature tar begins to be distilled whereupon the outlet is closed so that the material is subjected to further heating which may be of an exothermic nature under an increased pressure resulting from the closing of the outlet.—British Patent 157,795.

Ammonia From Peat.

By P. Brat.

In the production of ammonia by the treatment of peat in

an autoclave under a pressure of at least six atmospheres at 170-200° C. in presence of an alkaline reagent salts of water-soluble acids are obtained in the liquid in the autoclave. The peat residue containing this liquid is subjected to pressure, osmosis, or lixiviation and the salts of other metals are obtained by double decomposition. The lead and mercury salts are insoluble. The acids and their salts can be used as disinfectants or for therapeutic purposes. In addition to the basic reagents mentioned caustic potash and borax may be employed for the ammonia-producing reaction.—British Patent 159,193.

Peat and Peat Manure.

By R. B. Goldschmidt.

By exposure to the air, the water percentage of peat is brought to about 60, when the peat is placed in silos, treated with beetroot or molasses wash, and allowed to ferment. During the process of fermentation, the peat loses a great deal of its contained water, the amount of which is further reduced by compression. The product thus obtained may be subjected to a process of destructive distillation, with recovery of by-products or may be used as a manure.—British Patent 162,738.

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ANNOUNCEMENT IS HEREBY MADE OF THE DEATH ON MAY 10, 1920, OF

CHARLES M. CROUSE, Esq.,

OF SYRACUSE, N. Y., A CHARTER MEMBER OF THE AMERICAN PEAT SOCIETY.

APPLICATION FOR MEMBERSHIP

IN THE

American Peat Society

.....
(Date)

Mr. Charles Knap, *Secretary-Treasurer,*
American Peat Society,
Whitehall Building,
New York, N. Y.

Dear Mr. Knap:

Application is hereby made for membership in the American Peat Society. Check in the sum of $5.00 for dues during the first year is inclosed. This action is prompted by my interest in the utilization of peat and the welfare of the society.

Yours very truly,

.....
(Signature)

.....
(Address)

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Journal of the American Peat Society

Incorporated

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Published by the Society

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AMERICAN PEAT SOCIETY

SCOPE AND PURPOSE.

The American Peat Society was organized at the national exposition at Jamestown, Va., on October 23, 1907, and was incorporated in 1912. Its purpose is to disseminate information concerning the origin, geographic distribution, physical and chemical properties, and uses of peat, muck, and humus, and to stimulate interest in the commercial utilization of the widely-distributed, valuable deposits of these substances in North America.

NATURE AND USES OF PEAT.

Peat is the organic residuum resulting from the arrested decomposition of leaves, twigs, roots, trunks of trees, shrubs, mosses, and other vegetation in areas continually covered or saturated with water. It may be identified as the dark-colored soil found in bogs and swamps, commonly called muck. The commercial uses of peat are numerous and varied. In the countries of northern Europe it is used for fuel and as the basis for many manufacturing industries. Gas, charcoal, coke, and a number of valuable by-products are produced from it. Peat moss, marsh grass, and fibrous peat are employed in the manufacture of surgical dressings, of rugs, of packing material, of artificial wood, of paper, and of substitutes for cotton and woolen cloth. In the United States peat is utilized chiefly as an ingredient of fertilizers and stock food and as a crop soil.

ECONOMIC ASPECTS OF PEAT.

The United States contains about 12,000 square miles of undrained land estimated to be capable of yielding nearly 14 billion short tons of air-dried peat. The average deposit will yield 200 tons per acre foot. The peat areas are distributed throughout the Great Lake, New England, and Atlantic and Pacific Coast States. The peat deposits of Canada cover 37,000 square miles. The annual value of the products made from peat in the United States amounts to about $1,000,000. The profits received from the cultivation of peat and muck land are far in excess of this figure. European countries annually consume about 50 million tons.

MEMBERSHIP.

The present membership of the American Peat Society consists largely of agriculturists and peat producers. Persons interested in agriculture, in soil fertilization, in the chemical and bacteriological aspects of vegetal matter, and in

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It has been in operation now for about *forty-five days. No changes have been made and no break-downs have been reported during that time.*

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Very truly yours,

HENNEPIN ATOMIZED FUEL COMPANY
(Signed) F. E. BRYAN, *President.*

It is my 23 years of actual experience in peat utilization that counts.

HERBERT GARNETT,
P. O. Box 136,
Minneapolis, Minn.